INVESTIGATION OF A BIOBEHAVIORAL INTERVENTION'S IMPACT ON PHYSIOLOGIC STATE, PERCEIVED STRESS & AFFECT: A PILOT STUDY OF THE EFFECTS OF LAUGHTER YOGA

by

Jacqueline M. Killian

Dissertation submitted to the Faculty of the
PhD of Nursing Science Graduate Program
Uniformed Services University of the Health Sciences
In partial fulfillment of the requirements for the degree of
Doctor of Philosophy 2015

Distribution Statement

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Daniel K. Inouye Graduate School of Nursing

PhD Program in Nursing Science
Dissertation Defense
Doctor of Philosophy Degree

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TITLE: *Investigation of a Biobehavioral Intervention's Impact on Physiological State, Perceived Stress, Affect, General Health & Resilience*

Date of Defense: July 23, 2015 from 3pm to 5pm.

The decision of the Dissertation Committee is:

PASS

A. Both the proposal and the oral defense are satisfactory: _____
B. Minor changes are recommended by the Dissertation Committee and are to be made to the satisfaction of the Dissertation Chairperson: ✓

DEFER

A. Major changes in the proposal are required. Changes must be made to the satisfaction of the Dissertation Chairperson: _____
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ABSTRACT

Title of Dissertation: Investigation Of A Biobehavioral Intervention's Impact On Physiologic State, Perceived Stress & Affect

Jacqueline M. Killian, PhD in Nursing Science, 2015

Thesis directed by: Penny Pierce, PhD, RN, FAAN, Professor and Chair of PhD in Nursing Science Program of the Daniel K Inouye Graduate School of Nursing, Uniformed Services University of the Health Sciences

Dissertation presented at the Daniel K. Inouye Graduate School of Nursing, Uniformed Services University of the Health Sciences for public defense on Thursday, July 23, 2015 at 1500 hours in accordance with the requirements for the degree of Doctor of Philosophy in Nursing Science.

The overall objective of this thesis was to investigate the use of a novel biobehavioral intervention as a means of mitigating the effects of stress and identifying protective factors associated with resilience in a military medical and graduate student population. The rational for the use of a mixed method design is due to the complexity of the individual's stress response, which includes both physiologic and psychological implications.

Manuscript 1 examined the method of data collection to obtain heart rate variability measures, which have shown significant potential as a noninvasive biomarker for autonomic nervous system performance. This pilot study specifically investigated the test-retest reliability of two commercially available heart rate monitoring devices for use in medical research. The results provide support for the method of data collection utilized for the dissertation pilot study outlined in manuscript 3.

The biobehavioral intervention selected for the dissertation pilot study, laughter yoga, is a non-traditional method of promoting health and wellness that is largely unknown in the healthcare community. Manuscript 2 introduces the concept of laughter yoga and provides an overview of the current status of the literature and a methodological review.

Manuscript 3 presents the results of the investigation of the effect of participation in laughter yoga on measures of heart rate variability, peak expiratory flow rate as well as participants' perceptions of their stress level, positive affect, negative affect, general health and resilience.

The results of the dissertation presented contribute to the growing body of evidence regarding the physiologic and psychological impact of laughter yoga participation. The findings suggest that laughter yoga participation can increase peak expiratory flow rate, positive affect, mental health and resilience while also decreasing stress, symptoms of depression and negative affect. Unanticipated outcomes included the positive effect participants reported regarding their personal relationships and other health behaviors. The implications of these results and directions for future research are presented.

Keywords: Laughter yoga, heart rate variability, portable heart rate monitor, HRV, test-retest reliability, concept analysis, complementary and alternative medicine, positive affect, resilience

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Jacqueline M. Killian

November 3, 2015

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Clebe McClary Award, Squadron Officer School, one awarded in class of >500 students, for the one who best exemplifies Selflessness, Integrity, Dedication and Motivation.	Squadron Officer School Peers
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Army Commendation Medal	U.S. Army
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Date Conducted/Published	Title of Research/Publication	Role
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Effect of Laughter Yoga on Military Graduate Students: A Pilot Study

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RUNNING HEAD: EFFECTS OF LAUGHTER YOGA

EFFECTS OF LAUGHTER YOGA

Abstract

Objectives: The intent of the study was to explore the use of the biobehavioral intervention, laughter yoga, to mitigate the physiologic and psychological effects of stress within a military graduate student population.
Design: Mixed method quasi-experimental pre-test post-test wait-listed group design
Settings/Location: This study occurred on the campus of a military university
Subjects: Forty-one military graduate students age 23 to 52 (M=31) were randomly assigned to experimental and wait-list control groups.
Intervention: Four laughter yoga sessions lasting 60 minutes each, two sessions per week for a two-week period.
Outcome measures: Measures of heart rate variability, peak expiratory flow rate, Perceived Stress Scale, Positive Affect Negative Affect Scale, Patient Health Questionnaire 8, Standard Form 36, and Connor-Davidson Resilience Scale scores, as well as participant responses to open-ended questions.
Results: Compared to baseline, subjects showed statistically significant decreases in measures of heart rate variability and increases in peak expiratory flow rate, positive affect, resilience and general health and mental health scores. Subjects reported improvements in mood, relationships and health behaviors in qualitative responses.
Conclusions: This pilot study provides preliminary evidence that laughter yoga may improve physiologic state, psychological health and unexpected benefits in personal, social and professional relationships..

Keywords: laughter yoga, stress, stress management, positive affect, resilience, simulated laughter, peak expiratory flow rate

Effect of Laughter Yoga on Military Graduate Students: A Pilot Study.

Introduction

Stress affects people on both a physiologic and psychological level. The physiologic response to stress involves multi-system mechanisms that modulate vital functions during the anticipation or response to a stressor, and return to homeostasis.[1, 2] Psychological response to stress involves the individual's perception of the stressful situation, or the anticipation of an impending stressor, that subsequently influences an individual's reaction and eventual outcome.[3, 4] Stress has also been shown to be transmissible, whereby observing another person in distress can increase the concentration of the stress hormone cortisol in the observer.[5] Research suggests that approximately 30% of military personnel and Department of Defense employees have reported high levels of work induced chronic stress.[6, 7] Furthermore, a high correlation was observed between an increase in chronic stress and an increase in depression, work related injuries, missed work days, a negative perception of superiors, decreased physical health and lower quality of work.[6, 7] If left untreated, chronic high stress increases the likelihood of an individual developing mental health problems such as depression and anxiety, in addition to physical health problems such as heart disease, cancer, asthma, and gastrointestinal disturbances.[6-8] These health problems result in loss of quality of life for the individual, and adversely impacts their family and community through a negative feedback loop in which stress from the work environment is propagated to the home environment and *vice versa*.[9] Furthermore, chronic stress negatively impacts work productivity, and is estimated to cost $150 billion dollars annually.[6]

Effective interventions for the treatment of stress-related health problems typically involve medication regimens, psychological counseling and perhaps alternative therapies such as

mindfulness meditation and various forms of exercise.[10] Each of these interventions have key limitations such as side effects of medication from long-term use, financial cost or amount of time investment required. In addition, many of these treatments are not always well received, adhered to or sought after due to potential perceived stigma of having a 'mental disorder,',fear of retribution or dismissal from work advancement opportunities, and the unwillingness to admit the need for help.[9]

Therefore, the main goal of this work was to identify an alternative stress treatment that is cost effective, easy to use and implement, requiring minimal to no instrumentation and is free of side effects. The main objective of this work is to evaluate laughter yoga (LY) as an innovative self-management strategy to reduce stress and improve wellness as a self-directed, low-cost biobehavioral intervention for military personnel.

Dr. Madan Kataria conceived laughter yoga in 1995,[11] as a form of yoga that utilizes yogic breath work accompanied by the sound 'HA' and 'HO' upon exhalation to simulate laughter. During a LY session, laughter is initiated, without the use of humor, comedy or jokes, through laughter exercises that involve the vocalization of 'HA' and 'HO' while executing gentle body movement. These exercises alternate with slow, easy, deep breaths and are accomplished in a small, non-threatening group environment. In annunciating the sounds ('HA' and 'HO'), subjects mimic laughter, often resulting in spontaneous laughter due to the interaction of the group. The beneficial physiologic effects of laughter such as decreased blood pressure, increased natural killer cell activity, improved respiration, decreased stress and elevated pain tolerance, are well documented in the literature.[12-16] Favorable psychological effects such as improved positive emotions, mood and perception of quality of life have also been reported in laughter yoga studies.[17-20]

Even though the beneficial effects of laughter have been documented,[9] the use of laughter as a therapeutic intervention for military populations has not been studied. We selected a convenience sample of military graduate students for this pilot study to explore the feasibility and efficacy of using laughter yoga in a military population,. More specifically, in this mixed method pilot investigation, the impact of laughter yoga on subjects' physiologic (heart rate variability, peak expiratory flow rate) and psychological (self-reported perceived stress level, affect, general health, resilience) health during a short, two-week period was assessed.

Materials and Methods

Subjects

A total of 43 military graduate students volunteered to participate in the study. Two left the study after the baseline measurement session citing academic workload constraints (n = 41). The subjects were from different branches of the US militaryenrolled in allied health graduate education programs (see Table 1 for sample characteristics). Inclusion criteria comprised military status and current enrollment in one of the university graduate programs. Exclusion criteria included: hernia, heart disease with any history of angina, persistent cough with breathlessness, uncontrolled high blood pressure, urinary incontinence, epilepsy, advanced hemorrhoids, major surgery within the past three months or complains of severe backache, acute symptoms of cough, cold or fever [21]. The university Institutional Review Board approved the study. Command support and authorization provided access to the student body for recruitment.

Table 1. *Sample Characteristics by Group*

Characteristic	Experimental Group (*n*=20) Frequency		Control Group [a] (*n*=21) Frequency	Percent
Age	*M* = 31 (23 – 52) [b]	100%	*M* = 29 22 – 46 [b]	100%
Gender				
Men	10	50%	5	24%
Women	10	50%	16	76%
Married	13	65%	7	33%
Not Married	7	35%	14	67%
Academic Program				
Biomedical Sciences	1	5%	1	5%
Graduate School of Nursing	8	40%	5	24%
Medical Clinical Psychology	0	0	1	5%
Public Health	1	5%	0	0
School of Medicine	10	50%	14	66%
Branch of Service				
Air Force	4	20%	10	48%
Army	7	35%	4	19%
Navy	8	40%	7	33%
Public Health	1	5%	0	0

Note. [a.] Wait-listed control group. [b.] Depicts age range in years.

Subjects were randomly assigned to either an experimental or wait-listed control (WLC) group. Each group was divided into two subgroups of 10-11 members in accordance with the LY guidelines for optimal group size[21].Physiologic data and self-report instruments (see Table 2) were collected from both groups prior to the intervention period (O_1). The two experimental sub-groups participated in laughter yoga (LY) during weeks one and two (see Figure 1), while the WLC group did not participate in LY and instead continued with their usual life activity. At the end of the first two weeks, data (summarized in Table 2), were collected a second time for both groups, (O_2). The WLC group participated in LY during weeks three and four of the study, while the experimental group returned to their usual activities. At the end of week four, all

subjects were measured for the last time (O_3) (see Figure 1). Additionally, HRV, PEFR and qualitative data were also collected at the beginning and end of each LY session.

Table 2. Laughter Yoga Study Measures and Time Points for Experimental Group and Wait-Listed Control Group

	Time Point						
Measure	Pre-Study	Week 1	Week 2	End of Week 2	Week 3	Week 4	End of Week 4
Demographic Questionnaire	X /WLC						
Heart Rate Variability	X /WLC	X*	X*	X /WLC	WLC *	WLC *	X/WLC
Peak Flow Measure	X /WLC	X*	X*	X /WLC	WLC *	WLC *	X/WLC
Perceived Stress Scale	X /WLC			X /WLC			X/WLC
Positive Affect Negative Affect Scale	X /WLC			X /WLC			X/WLC
SF36	X /WLC			X /WLC			X/WLC
Connor Davidson Resilience Scale	X/WLC			X/WLC		X/WLC	
LY Session Surveys		X*	X*		WC *	WC *	
Post Intervention Survey				X			WC

X= Experimental group; WC= Wait-listed control group; * Physiologic measures and surveys accomplished at each LY session.

Figure 1. Experimental Design

R	O_1	X	O_2	~X	O_3
R	O_1	WC	O_2	WCi	O_3

(R= Randomized; O_1= Observation/Measurement occurring the day before the 4 week study begins; O_2= Observation/Measurement occurring at the end of week 2; O_3= Observation/ Measurement occurring at the end of week 4; X= Experimental Group; WC= Wait-listed Control Group; ~X= Experimental Group post intervention; WCi =Wait-listed Control Group engaging in intervention)

Laughter Yoga Protocol

A certified laughter yoga teacher (CLYT) led all of the sessions having been trained and certified by Dr. X. Laughter was simulated and practiced as a group exercise, promoted through eye contact and childlike playfulness amongst the group members. Each LY session was 60-minutes long. At the start of each? session, peak flow was measured three times using a peak flow meter. Subjects were seated for a 5-minute rest period, followed by 10-minutes of cardiac data collection using a portable heart monitoring device, the emWave2 (HeartMath LLC, Boulder Creek, CA, USA). Next, subjects engaged in 15 minutes of laughter exercises, followed by 5 minutes of laughter meditation and 15 minutes of relaxation meditation in the form of a guided body scan during which participants were instructed to relax specific muscles starting from their head and moving sequentially down the body to their toes. Participants then engaged in ten minutes of post intervention cardiac data collection, a second set of peak flow measurements and post intervention survey responses were collected. All subjects were scheduled to attend four LY sessions over a two-week period.

Physiological Measures

Cardiac data were collected at each of the study measurement sessions O_1, O_2, O_3 (see Figure 1), as well as at the beginning and end of each LY session using the emWave2. This device uses pulse oximetry technology or photophlethysmography (PPG), which relies on the pulse wave circulated through the vascular tree with ventricular contraction, thereby measuring the pulse wave as a surrogate for heart rate via a sensor attached to the participant's earlobe. The emWave 2 captures the heart beat and extracts the inter-beat-interval between consecutive R-to-R peaks. Pre and post-intervention data were acquired for ten minutes based on the

recommendation provided by the Task Force of the European Society of Cardiology and the North American Society of Pacing and Electrophysiology. [22].

Peak flow measurement, (peak expiratory flow rate, PEFR), determines the amount of air one can expel out of the lungs and is an indicator of the openness of the airways. Three peak flow measurements were obtained using a handheld peak flow meter and then annotated for each participant at same time points as cardiac data collection. The mean of these three PEFR measurements was utilized to determine whether participation in LY increased PEFR[23].

Calculation of Measures of HRV

The IBI data was transferred from the emWave devices onto a computer, converted to the text file format (.txt) and processed using the Kubios Software package.[24] First, trends in the raw IBI time series data were removed using the smooth priors regularization.[24] Non-physiological outliers were removed using the 'medium' level of correction, which identifies any R-to-R intervals that are longer or shorter than 0.25 seconds when compared to the average. Second, the corrected IBI time series was re-sampled at 4 Hz and HRV measures, pertaining to the time and frequency domain of the IBI data sequence were calculated. For this study, the time domain variables of interest selected for comparison were: the mean of the R-to-R intervals (Mean RR), the standard deviation of the R-to-R intervals (STD RR), mean heart rate (Mean HR), standard deviation of heart rate (STD HR), and the root mean square of successive differences between inter-beat intervals (RMSSD). The frequency domain variables of interest selected for comparison were: low frequency (LF), high frequency (HF) and the ratio of low frequency to high frequency (LF/HF).

Self-Report Measures

Subjects were provided with the self-report measures (Table 2) to assess the impact of participation in LY on perceived level of stress, affect, general health and resilience. Additionally, responses to open-ended questions were obtained following participation as a means to determine subjects' description of their experience engaging in LY (See Table 2 for a list of all measures and time points).

The Perceived Stress Scale (PSS), a standardized validated 10-item scale (Cronbach's alpha .76)[25, 26] was used to determine the degree to which each participant perceived life's situations as stressful during the previous two weeks. Items were scored on a 5-point Likert scale, with scores ranging from zero to 40, with higher scores indicating a greater degree of perceived stress.[26]

The Positive Affect Negative Affect Scale (PANAS)[27], a standardized, validated 20-item questionnaire comprised of adjectives, was used as a measure of participant affect. In the scale 10 of the items are associated with positive affect (PA) and 10 items with negative affect (NA). Scored on a 5-point Likert scale, two scores were generated, one for PA, the other for NA. Scores range from 10-50 with higher scores indicating higher affect. The PANAS is noted for strong internal consistency for both PA and NA scales when used in adult populations with reported Cronbach's alpha of .89 for PA and .85 for NA, respectively.[28]

The Patient Health Questionnaire 8 (PHQ8), a validated standardized 8-question instrument (Cronbach's alpha .89) was administered to measure symptoms of depression[29]. The items are scored on a scale of 0 (not at all) to 3 (nearly every day). Scores range from 0-27 with higher scores indicating greater symptoms of depression.

To measure general health, the Standard Form 36 Health Survey (SF36), [30] a validated standardized survey comprised of 8 subscales was administered. Scores are transformed to a 0-

100 scale with lower scores indicating worse health status and a score of 100 indicating best health status. The eight subscales include a measure of vitality, physical functioning, bodily pain, general health perceptions, physical role functioning, emotional role functioning, social role functioning and mental health. The SF 36 has shown to perform well with both general and specific populations and has well-established reliability for all eight scales with Cronbach's alpha ranging from .68 to .93.[31]

To measure resilience, the Connor-Davidson Resilience Scale (CD-RISC) was included in the survey booklet. [32] The CD-RISC is a 25-item survey, with each item scored from 0 (not at all true) to 4 (true nearly all of the time). Scores range from 0 to 100 with higher scores corresponding to greater resilience.[33]

Following laughter yoga, subjects completed a series of open-ended questions. Content analysis of participant responses to these questions was utilized to examine the words and phrases subjects used to describe their laughter yoga experience.

Statistical Analysis.

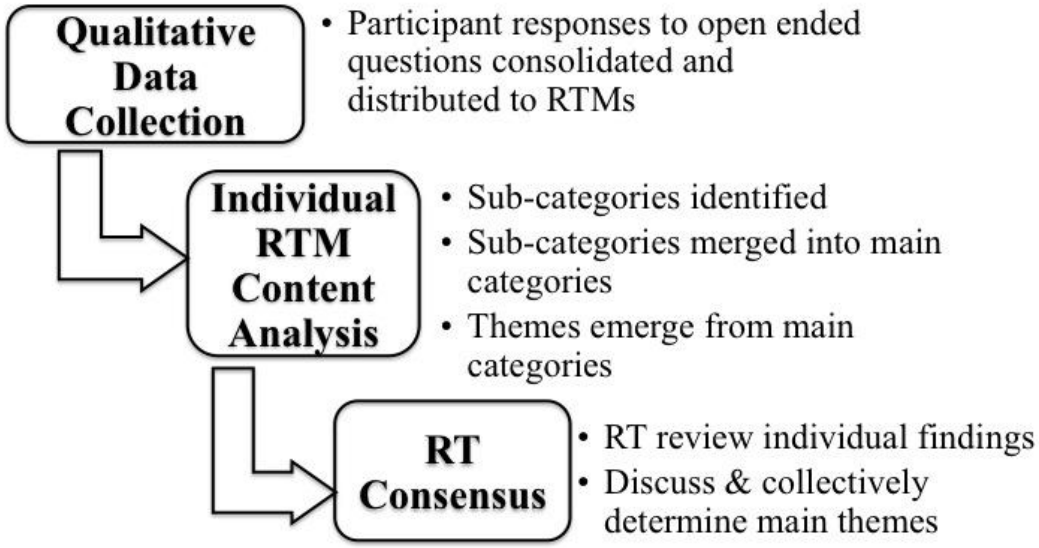
A power analysis was conducted using SAS version 9.3 for Windows (SAS Institute Inc., Cary, NC, USA), which indicated a sample size of 30 for within groups comparison and paired samples t-test, with Cohen's d of 1.0, would result in power of at least .91, depending on the within-subjects correlation. With a sample size of 15 for between groups comparison, independent samples t-test with Cohen's d of 1.0 would result in a power of .78.

Statistical Analysis was performed using the SPSS statistical software package version 22 (IBM Corp, Armonk, NY, USA). *A priori* significance level of $p < .05$ was delineated to signify a statistically significant difference. The distribution of the data was first checked for normality using the Kolmogorov-Smirnov test, and if normality was violated, data were log transformed to

a normal distribution to allow for analysis with parametric statistics. Independent samples *t*-test and paired samples *t*-tests were used to determine significant differences pre and post-intervention among groups and between subjects' means pre and post intervention. For data that could not be transformed to a normal distribution, the following non-parametric analyses were utilized: Friedman's two-way analysis of variance by ranks with pairwise comparison with Bonferroni correction for multiple comparisons; Mann-Whitney U to determine if there were differences between the experimental group as compared to WLC during the first two weeks of the study; and Wilcoxon Signed Rank analysis to see if median difference between pre and post scores were present for between-subjects comparison.

The Principal Investigator (PI) and four research team members (RTMs) conducted an independent qualitative content analysis of open-ended responses by reducing the words, phrases, and sentences, provided by the subjects into content-related categories. Key themes and patterns were isolated and interpreted, which led to a refined understanding of the subjects LY experience (see Figure 2).[34] First, qualitative content was independently read through several times by each RTM for familiarization of the content in its entirety. Next, each RTM categorized the units into sub-categories, which were then formed into categories. Abstraction continued through the emergence of main themes. Finally, the five-member team reviewed and compared individual analyses, noted similarities, and discussed any differences until a consensus, of major themes and subthemes, was collectively determined.

Figure 2. Content analysis process for qualitative data



Note. RTM = Research team member. RT = Research team.

Results

Post-hoc power analysis conducted using SAS version 9.3 for Windows (SAS Institute Inc., Cary, NC, USA), determined that for between groups comparison of $n = 20$ versus $n = 21$ per group, with an alpha of .05 and .8 power to detect a Cohen's d of .90 for large effect size. For within groups comparisons of 41 pairs, with an alpha .05, and .8 power to detect Cohen's d of .64 for moderate effect size.

Physiologic Measures

The independent samples *t*-test comparing HRV measures and PEFR between the experimental and control groups indicated no significant difference at baseline, (see Table 3), nor post intervention (see Table 4). Paired samples t-test to assess the impact of LY on HRV and PEFR measures suggested statistically significant decreases for STD RR, RMSSD, HF and statistically

significant increase of PEFR. These paired samples t-test were conducted with 17 subjects, as four were excluded due to equipment failure.

Table 3. *Results of Independent Samples t test Comparing Pre Intervention Physiologic Measures of Heart Rate Variability (HRV) and Peak Expiratory Flow Rate (PEFR) by group at baseline*

	Experimental (n=20)		Wait-listed Control (n=21)				
Variable	*M*[b]	*SD*[b]	*M*[b]	*SD*[b]	*t*	*p* (< .05)	95% *CI* for Mean Difference
Mean RR	885.48	113.78	887.02	147.85	-0.036	0.972	-88.91, 91.36
STD RR	1.71	0.21	1.73	0.17	-0.325	0.747	-0.15, 0.11
Mean HR	69.39	8.98	69.89	11.21	-0.152	0.880	-7.24, 6.23
STD HR[a]	0.70	0.19	0.71	0.13	-0.351	0.728	-.13, 0.09
RMSSD[a]	47.61	21.30	53.81	29.35	-0.744	0.462	-23.15, 10.74
LF[a]	3.18	0.51	3.19	0.33	-0.075	0.941	-.30, 0.28
HF[a]	2.79	0.35	2.88	0.39	-0.763	0.450	-.34, 0.16
LF/HF[a]	0.36	0.36	0.39	0.39	0.671	0.507	-0.17, 0.33
PEFR[a]	2.67	0.09	2.67	0.10	0.045	0.964	-0.06, 0.06

Note. *M*= mean; *SD* = standard deviation; *t* = t statistic; *CI* = Confidence Interval. [a] signifies variable log 10 transformed. [b] values in these columns were rounded to the hundredth of a decimal. Results indicate no significant difference in physiologic measures for experimental group when compared to control at baseline.

It would be helpful to have the results presented between the tables so they don't run up against each other

Table 4. *Results of Independent Samples t-test Comparing Post Intervention Physiologic Measures of Heart Rate Variability (HRV) and Peak Expiratory Flow Rate (PEFR) of the Experimental and Control groups*

	Experimental (n=20)		Wait-listed Control (n=21)				
Variable	*M*[b]	*SD*[b]	*M*[b]	*SD*[b]	*t*	*p* (< .05)	95% *CI* for Mean Difference
Mean RR	869.85	120.96	850.65	103.93	0.54	0.592	-52.79, 91.19
STD RR	49.78	21.77	51.97	18.13	-0.348	0.730	-14.98, 10.58
Mean HR	70.85	10.08	71.99	8.71	-0.382	0.705	-7.15, 4.88
STD HR[a]	0.67	0.17	0.74	0.24	-0.995	0.326	-0.20, 0.07
RMSSD[a]	1.56	0.212	1.61	0.18	-0.922	0.363	-0.18, 0.07
LF[a]	3.10	0.408	3.14	0.34	-0.304	0.762	-0.27, 0.20
HF[a]	2.65	0.45	2.79	0.40	-1.014	0.317	-0.41, 0.14
LF/HF[a]	0.45	0.34	0.35	0.44	0.813	0.421	-0.15, 0.36
Peak Flow[a]	2.71	0.08	2.69	0.09	0.749	0.459	-0.03, 0.07

Note. *M*= mean; *SD* = standard deviation; *t* = t statistic; *CI* = Confidence Interval. [a] signifies variable log 10 transformed. [b] values in these columns were rounded to the hundredth of a decimal. Results indicate no significant difference in physiologic measures for experimental group when compared to control following intervention.

Table 5. *Results of Paired Samples t Test Comparing Pre and Post Intervention Physiologic Measures of Heart Rate Variability (HRV) and Peak Expiratory Flow Rate (PEFR) of Experimental and Control groups*

	Time Point 1			Time Point 2						
Variable Group	n T1	M[b]	SD[b]	n T2	M[b]	SD[b]	*df*	*t*	*p* (>.05)	95% CI for Mean Difference[b]
Mean RR										
Ex. Grp.	20	876.14	108.74	19	769.85	120.96	19	0.203	0.841	-58.80, 71.39
WLC[a]	17	2.94	0.07	21	2.93	0.05	17	0.657	0.521	-0.02, 0.04
STD RR										
Ex. Grp.[a]	19	1.72	0.21	19	1.66	0.18	19	3.111	0.006*	0.02, 0.10
WLC	17	57.13	20.58	17	50.91	14.40	17	1.012	0.327	-6.81, 19.25
Mean HR										
Ex. Grp.	19	70.07	8.69	19	70.85	10.08	19	-2.91	0.775	-6.46, 4.89
WLC[a]	17	69.89	11.21	17	70.93	8.39	17	-.431	0.672	-6.15, 4.07
STD HR										
Ex. Grp.	19	5.51	2.10	19	5.03	1.87	19	1.599	0.172	-0.15, 1.11
WLC[a]	17	0.71	0.13	17	0.74	0.26	17	-.586	0.566	-0.15, 0.09
RMSSD										
Ex. Grp.	19	48.21	21.71	19	40.62	22.05	19	2.494	0.023*	1.20, 13.98
WLC	20	53.81	29.35	17	41.32	9.42	17	1.998	0.063	-.76, 25.74
LF										
Ex. Grp.[a]	19	3.21	0.50	19	3.10	0.41	19	1.886	0.075	-0.01, 0.21
WLC[a]	17	3.19	0.33	17	3.17	0.33	17	0.106	0.917	-0.25, 0.27
HF										
Ex. Grp.[a]	19	2.80	0.36	19	2.65	0.45	19	2.378	0.029*	0.02, 0.27
WLC[a]	17	2.88	0.39	17	2.78	0.26	17	1.32	0.206	-0.06, 0.27
LF/HF										
Ex. Grp.[a]	19	0.41	0.35	19	0.45	0.34	19	-0.471	0.643	-0.23, 0.15
WLC[a]	17	0.30	0.39	17	0.39	0.41	17	-0.805	0.433	-0.33, 0.15
PEFR										
Ex. Grp.	20	482.5	96.77	20	523.5	88.92	20	-4.442	0.000*	-41.28, -21.68
WLC[a]	21	2.67	0.10	21	2.69	0.09	21	-1.046	0.308	-41.28, -21.68

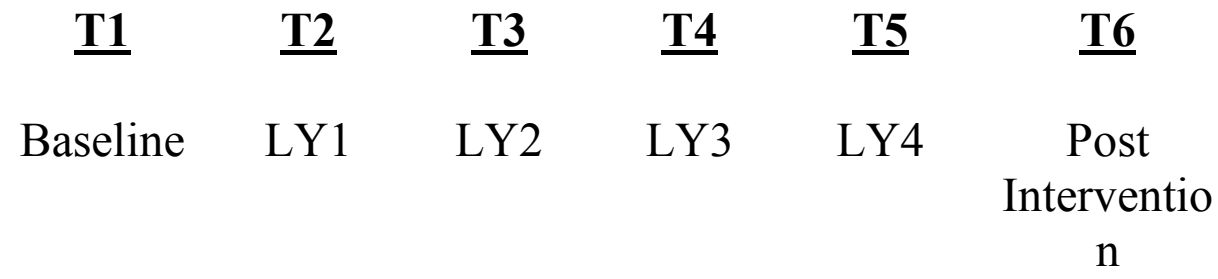
Note. *M*= mean; *SD* = standard deviation; *t* = t statistic; Ex Grp = Experimental group; WLC = Wait-listed control group. *Indicates significant finding, $p \leq .05$. [a] signifies variable log 10 transformed. [b] values in these columns were rounded to the hundredth of a decimal. Results of within subjects analysis indicate three HRV measures with significant difference in scores for STD RR, RMSSD and HF, as well as for Peak Expiratory Flow Expiratory Flow Rate.

In the paired *t*-test the STD RR measure was observed to have decreased from Time 1 ($M = 1.72$, $SD = 0.210$) to Time 2 ($M = 1.66$, $SD = 0.18$), $t(19) = 3.11$, $p = .006$ for the

experimental group. The mean decrease in the STD RR measure was 0.06 (95% CI 0.02 to 0.10), a large effect size (eta^2 = 0.2).[35] The experimental group's mean RMSSD decreased from Time 1 (M = 48.21, SD = 21.71) to Time 2 (M = 40.62, SD = 22.05), t (19) = 2.50, p = .023. The mean decrease in RMSSD was 7.59 (95% CI 1.2 to14), a large effect size (eta^2 = 0.2). The HF results for the experimental group also decreased from Time 1 (M = 2.80, SD = .36) to Time 2 (M = 2.65, SD = 0.45), t (19) = 2.38, p = .029. The mean decrease in HF was 0.15 (95% CI 0.02 to 0.27), a large effect size (eta^2 = 0.14). PEFR results for the experimental group increased from Time 1 (M = 482.5, SD = 21.64) to Time 2 (M = 523.5, SD = 88.91), t (20) = 4.44, p < .001. The mean increase in PEFR was 41 (95% CI -.21.68 to 41.28), a large effect size (eta^2 = 0.34) (refer to Table 5).

Repeated measures analysis was performed to determine if any significant differences occurred over six time points for the physiologic measures. The physiologic data were determined to be non-normally distributed using the Kolmogorov-Smirnov test (p < .05). Results of the Friedman test indicated that measures of STD HR and PEFR were significantly different for subjects engaging in laughter yoga over the six time-points (see Figure 3). Results for the analysis of the STD HR measure revealed statistical significance, (X^2 (5, n = 32) = 14.05, p = .015). Inspection of the median values showed a decrease from baseline (Md = 4.99) to T2 (Md = 4.15), which appeared to recover by post-intervention (Md = 4.89). Results of repeated measures ANOVA analysis of PEFR showed statistically significant difference (X^2 (5, n = 41) = 184.26, p < .001). Inspection of the median values showed a decrease from baseline (Md = 463.33) to T2 (Md = 317.16), which then increased by post-intervention (Md = 480).

Figure 3. Repeated Measure Analysis of Laughter Yoga Effect over Six Time Points



Physiologic data (heart rate variability (HRV) and peak expiratory flow rate (PEFR) were collected at baseline, then before and after each laughter yoga session (LY1 = first session, LY2 = second session, LY3 = third session, and LY4 = fourth session) and finally data was collected the week after the final laughter yoga session as the post-intervention measure.

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Self-Report Measures

Change scores were calculated as the difference between the scores obtained at the end of week two and the scores obtained at baseline. Resulting change score data were determined to be non-normally distributed using the Kolmogorov-Smirnov test ($p < .05$). Therefore, the nonparametric Mann-Whitney *U* was used for between groups comparison of the Experimental Group to the WLC Group. The results revealed significant differences in Positive Affect, SF 36 components: Role Emotional, Mental Composite Score, and Physical Component Summary scores (see Table 6). For within groups comparison, the Wilcoxon Signed Rank analysis showed increased participant scores for Positive Affect, SF36 Role Physical, SF 36 General Health, SF36 Mental Composite Score, and for the CD-RISC score (see Table 7). Although differences in change scores for the PSS, NA, and the PHQ8 were not statistically significant, 18 of the 41 subjects (45%) had decreased PSS scores, 31 of 41 subjects (76%) had decreased NA scores and 19 of 41 subjects (46%) had decreased PHQ8 scores post intervention (see Table 7).

Table 6. *Results of Self-Report Measure Change Score Comparison of Experimental and Wait-Listed Control (WLC) Group*

Variable	***N***	***Md***	**Mann Whitney *U***	**Test Statistic (*Z*)**	***p* (<.05)**	**Effect Size (*r*)**
Positive Affect			147.5	-1.633	< .005*	.26
Experimental Group	20	25.5				
WLC Group	21	2				
SF 36 Role Emotional			147.5	-1.633	.046*	.26
Experimental Group	20	8.33				
WLC Group	21	-8.34				
SF 36 Mental Health			320.5	2.91	.033*	.45
Experimental Group	20	5				
WLC Group	21	0				
SF36 Physical Component Summary			100	-2.695	< .005*	.42
Experimental Group	20	-.27				
WLC Group	21	2.14				

Note. *N* = number of subjects in each group; *Z* = Z score; *Indicates significant finding, $p \leq .05$; *r*= measure of effect size, using Cohen (1988) criteria of .1 = small effect, .3 = medium effect, and .5 = large effect.

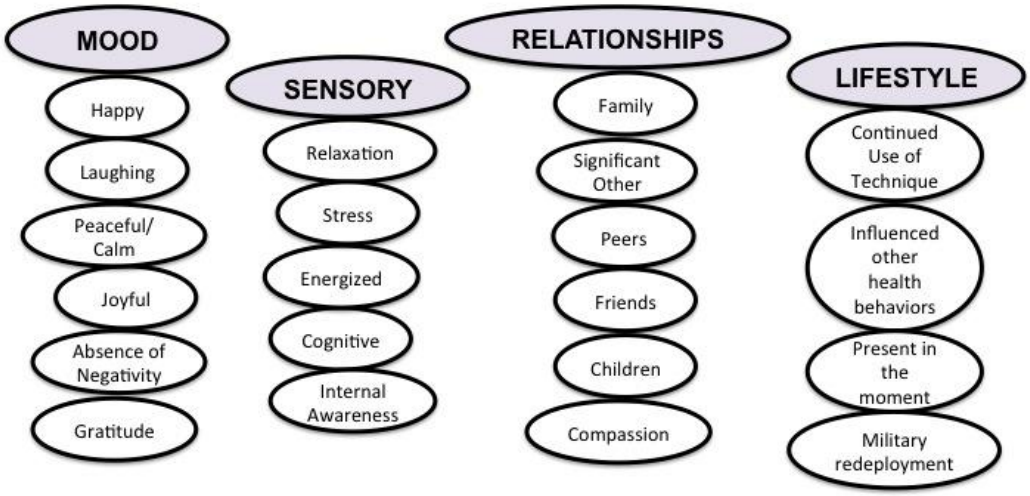
Table 7. *Results of Self-Report Measure Change Score Analysis*

Variable	***N***	**Test Statistic (*z*)**	***p* (<.05)**	**Observed Median**	**Effect Size (*r*)**	**% Score Change** Decrease / Increase
Perceived Stress Scale	41	.091	.928	0	.01	45% / 46%
Positive Affect Score	41	4.369	< .005*	11	.48	29% / 66%
Negative Affect Score	41	-1.789	.074	-1	.01	76% / 17%
PHQ 8 Score	41	-1.154	.248	0	.18	46% / 14%
SF 36 Role Physical Score	41	1.994	.046*	0	.22	17% / 32%
SF 36 General Health Score	41	2.137	.033*	5	.24	16% / 60%
SF36 Mental Composite Score	41	5.484	< .005*	12.9	.61	2% / 98%
Connor Davidson Resilience Scale	41	2.158	.031*	2	.24	27% / 66%

Note. Results of Wilcoxon Signed Rank analyses. *N* = number of subjects in each group; *Z* = Z score; *Indicates significant finding, $p \leq .05$; *r*= measure of effect size, using Cohen (1988) . criteria of .1 = small effect, .3 = medium effect, and .5 = large effect.

The open-ended questions resulted in a total of 191 verbal responses that were collected and reduced to four main themes with subthemes (see Figure 4). Subjects were asked to describe the LY session in 140 characters or less (a "tweet" description, commonly used for Twitter),[36];to list any feelings or sensations they felt or experienced following the LY session; and whether LY participation affected their stress level, their affect, or any other aspect of their life, and if so to provide an explanation. Participant responses ranged from merely one-word responses to several sentences. Four main theme, with a number of sub-themes, emerged from an analysis of the qualitative responses: 1) mood, 2) sensory responses lationships and, 4) lifestyle (see Figure 4).

Figure 4. Themes and Subthemes from Participant Responses Regarding the Impact of Laughter Yoga



Note. Main themes depicted in upper most touchstone shape with shaded background, subthemes of each main theme listed below each. Themes and subthemes derived from participant responses regarding how they were affected by participation in laughter yoga.

Discussion

The successful recruitment of 43 subjects within four weeks and a 95% retention rate demonstrates that LY may be an viable stress management option for military members. However, this retention rate may not be generalizable to all military populations as the subjects

enrolled in this study consisted of military students who were enrolled in health professions graduate programs. Nonetheless, offering LY to active duty service members in other career fields during accessible times such as lunch hour or immediately following work hours may increase the likelihood of participation.

Physiologic measures HRV measures reflect sympathetic and parasympathetic regulation and balance, with an increase indicating stronger parasympathetic influence whereas a decrease indicating more of a sympathetic effect[37]. We had anticipated that the chaotic movement of the diaphragm during laughter and the deliberate chest and abdominal expansion that occurs with the deep breathing, would increase the measures of HRV by stimulating the vagus and affecting neural regulation of the heart.[38] However, the results indicate significantly reduced measures of STD RR, RMSSD, and HF and were contrary to a previously published study.[30].However, these differences could be attributed to the subjects used for this study who were drawn from a young and healthy student population as compared to the previously published study in which subjects were much older (age = 50-60 years) and were awaiting heart or lung transplants[30]. In addition, the aerobic aspect of the LY exercises could actually be more stimulating and perhaps is a type of physiologic stressor, therefore reducing the HRV measures and impacting the recovery/refractory period following the LY session when measurement occurred.

There was a significant increase in PEFR between pre and post intervention suggesting that LY may contribute toward increasing lung capacity. This finding differed from Bennett, Parsons, Ben-Moshe, et al.,[18] who reported no change in lung function as measured by forced expiratory volume following intradialytic LY therapy in their study of hemodialysis patients. In addition, these authors also reported increased happiness, mood, and optimism while decreasing stress in their LY population that were not statistically significant. The results from this study

indicate that LY increases positive affect and resilience, as well as aspects of general health and mental health. Additional research have also reported that participation in LY improved psychological well-being[39], positive emotions, mood, life satisfaction,[20] aspects of self-efficacy, and general health,[40] while also decreasing stress,[10] depression,[20] and anxiety.[40] Analysis of LY's impact on perceived stress, negative affect, and depressive symptoms were not statistically significant however, a number of subjects did lower their scores (see Table 8) in these areas and further investigation of these outcomes is warranted.

A novel aspect of this study is the exploration of the language used by subjects to describe their LY participation and how they reported the ways in which they were affected. Subjects' open responses provide a window into the domains of life that were not obtained through physiologic or psychological measures. A few examples of the written responses are: "I felt happier as a result of doing the laughter, and my mom says I was happier", "My girlfriend said I was more agreeable after LY…. by the third and fourth session I felt connected to my group and was totally looking forward to laughing with them;" "I was less stressed and did not engage negatively with my children; because I was more calm, my husband was calmer too," "I noticed when I start to feel stressed, I smile, take a deep breath in and continue in the "stressed" environment with a more relaxed attitude," "I think I am more energetic and have greater ambitions… Overall I feel that I am and do achieve more on any given day."

Analysis of all participant responses revealed four themes or areas in which LY affected them (see Figure 4). LY positively influenced their *mood* through laughter, happiness, joy, gratitude, increased peacefulness or by removing negativity. Subjects also reported various *sensory* effects regarding increased relaxation, enhanced cognitive abilities such as focus and awareness in addition to decreased stress. Two other themes emerged regarding the manner LY

affected subjects' *relationships* and *lifestyle*. Overwhelmingly, subjects mentioned that they thought their personal relationships (with significant others, family, children, peers, and friends) improved during the LY intervention period. Some reported feeling more compassionate, that perhaps this positively impacted their relationships as well. In terms of lifestyle impact, subjects reported different instances in which they were using aspects of LY to cope with stressors in daily life; that as a result of LY participation they were making healthier life choices such as eating better, sleeping more, drinking less caffeine and alcohol, and increasing exercising. Some reported that LY encouraged them to be more present in the moment, thus decreasing their stress. Participant responses to the open-ended questions communicate that the impact LY had on these subjects positively affected many other domains not included in the outcome measures of the current study. The responses allude to other components that may contribute to the results such as the social aspect of the group activity, promotion of other beneficial health behaviors and cognitive effects that could be associated with productivity; all potential areas for future exploration.

The limitations of the study include quasi-randomization to groups, sample characteristics, as well as the dose of LY. During the study period, some of the participants had academic requirements forcing them to participate either during the first two weeks or the last two weeks and this partially influenced their group assignment (experimental or WLC). All of the participants were healthy and relatively fit due to their active duty military requirements, and therefore theoretically would not display as great a change in scores from baseline measures as perhaps a sample with physical or mental health issues . This sample of convenience may not necessarily translate to generalizability of the findings. Furthermore, an alternate intervention for comparison, such as a walking exercise program, and larger sample size could strengthen the

design. Lastly, the dose (4 sessions) and duration (2 weeks) were relatively short and investigation of varying dosage and duration of LY participation could quantify the amount, duration and extent of LY that will maximize outcomes. However, the HRV measures, self-report outcomes and synthesis of the open-ended questions were novel findings from this study. You may want to say more about this since you have said it is novel – your reader would want to know more about that

Conclusion

This mixed method pilot study contributes to the small but growing literature regarding LY by providing additional evidence of the impact of LY participation, for a military student population. However, the positive outcomes of the study warrant further investigation in other populations. Significant increases in PEFR, positive affect, general health, mental health, and resilience suggest that LY can mediate stress management. Participant responses regarding the LY experience provide novel information of the intervention's effect beyond that which the study focused. Say more about that, specifically that their responses of the influence of LY into other life domains was not expected and opens a new area of exploration. The challenge, for future research regarding the health benefits of LY participation, is in planning well-designed experimental designs that capture not only the impact onphysiologic and psychological aspects of health, but other factors, such as the impact of improved social support and positive changes in health behaviors that can also prove to be beneficial in the promotion of stress management and healthy living.

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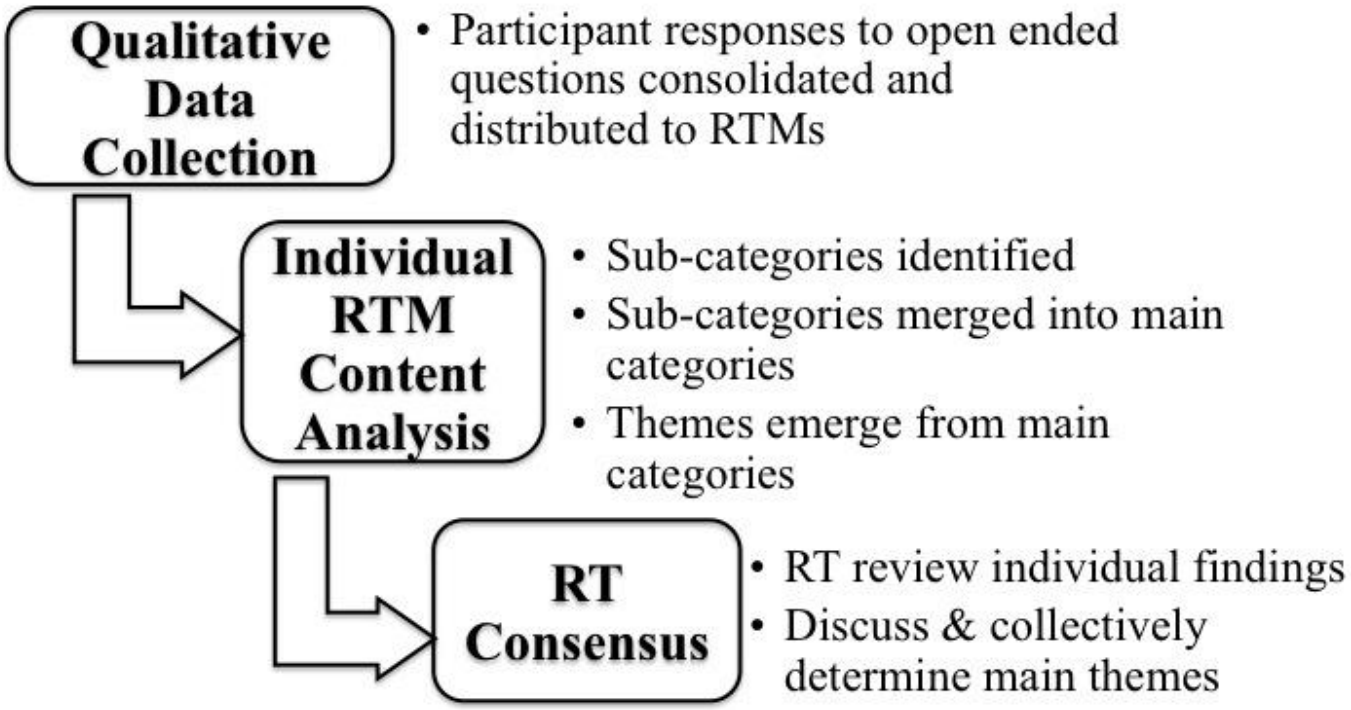
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Figure 1. Experimental Design

R	O_1	X	O_2	~X	O_3
R	O_1	WC	O_2	WCi	O_3

(R= Randomized; O_1= Observation/Measurement occurring the day before the 4 week study begins; O_2= Observation/Measurement occurring at the end of week 2; O_3= Observation/ Measurement occurring at the end of week 4; X= Experimental Group; WC= Wait-listed Control Group; ~X= Experimental Group post intervention; WCi =Wait-listed Control Group engaging in intervention)

Figure 2. Content analysis process for qualitative data



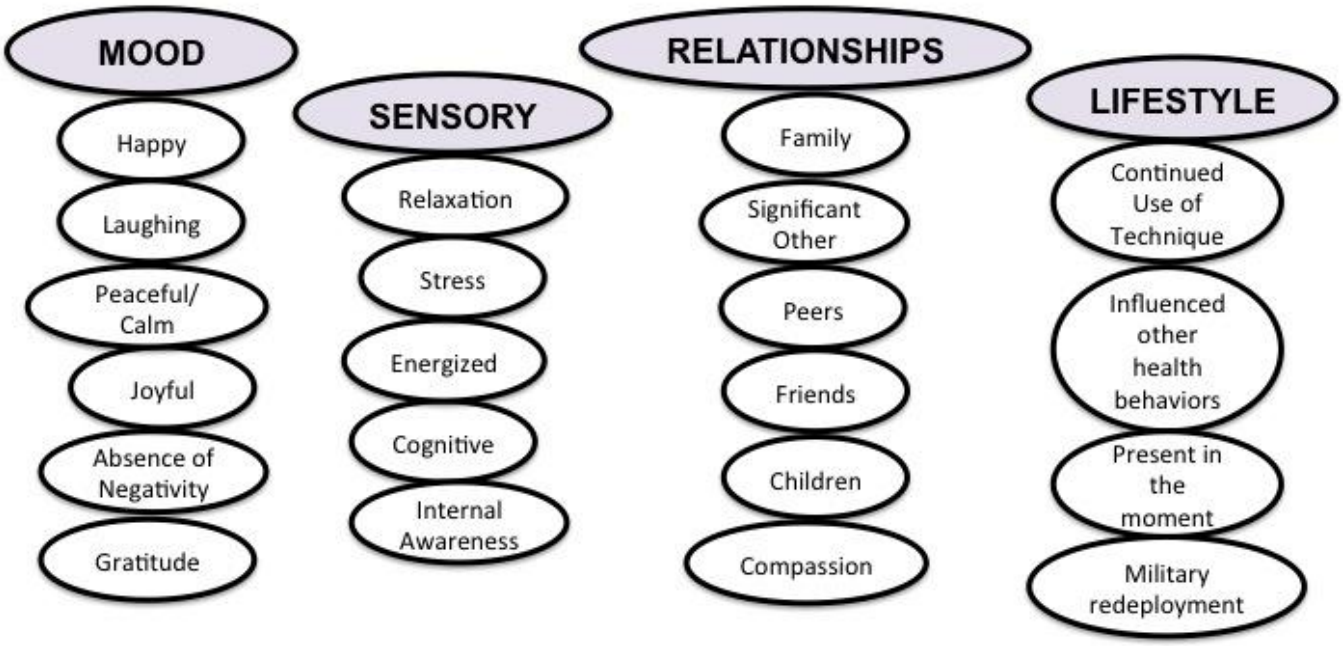
Note. RTM = Research team member. RT = Research team.

Figure 3. Repeated Measure Analysis of Laughter Yoga Effect over Six Time Points

T1	**T2**	**T3**	**T4**	**T5**	**T6**
Baseline	LY1	LY2	LY3	LY4	Post Intervention

Physiologic data (heart rate variability (HRV) and peak expiratory flow rate (PEFR) were collected at baseline, then before and after each laughter yoga session (LY1 = first session, LY2 = second session, LY3 = third session, and LY4 = fourth session) and finally data was collected the week after the final laughter yoga session as the post-intervention measure.

Figure 4. Themes and Subthemes from Participant Responses Regarding the Impact of Laughter Yoga



Note. Main themes depicted in upper most touchstone shape with shaded background, subthemes of each main theme listed below each. Themes and subthemes derived from participant responses regarding how they were affected by participation in laughter yoga.

Table 1. *Sample Characteristics by Group*

Characteristic	Experimental Group (*n*=20) Frequency		Control Group [a] (*n*=21) Frequency	Percent
Age	*M* =31 (23 – 52) [b]	100%	*M* = 29 22 – 46 [b]	100%
Gender				
Men	10	50%	5	24%
Women	10	50%	16	76%
Married	13	65%	7	33%
Not Married	7	35%	14	67%
Academic Program				
Biomedical Sciences	1	5%	1	5%
Graduate School of Nursing	8	40%	5	24%
Medical Clinical Psychology	0	0	1	5%
Public Health	1	5%	0	0
School of Medicine	10	50%	14	66%
Branch of Service				
Air Force	4	20%	10	48%
Army	7	35%	4	19%
Navy	8	40%	7	33%
Public Health	1	5%	0	0

Note. [a.] Wait-listed control group. [b.] Depicts age range in years.

Table 2. Laughter Yoga Study Measures and Time Points for Experimental Group and Wait-Listed Control Group

	Time Point						
Measure	Pre-Study	Week 1	Week 2	End of Week 2	Week 3	Week 4	End of Week 4
Demographic Questionnaire	X /WLC						
Heart Rate Variability	X /WLC	X*	X*	X /WLC	WLC *	WLC *	X/WLC
Peak Flow Measure	X /WLC	X*	X*	X /WLC	WLC *	WLC *	X/WLC
Perceived Stress Scale	X /WLC			X /WLC			X/WLC
Positive Affect Negative Affect Scale	X /WLC			X /WLC			X/WLC
SF36	X /WLC			X /WLC			X/WLC
Connor Davidson Resilience Scale	X/WLC			X/WLC			X/WLC
LY Session Surveys		X*	X*		WC *	WC *	
Post Intervention Survey				X			WC

X= Experimental group; WC= Wait-listed control group; * Physiologic measures and surveys accomplished at each LY session.

Table 3. *Results of Independent Samples t test Comparing Pre Intervention Physiologic Measures of Heart Rate Variability (HRV) and Peak Expiratory Flow Rate (PEFR) by group at baseline*

	Experimental (n=20)		Wait-listed Control (n=21)				
Variable	*M*[b]	*SD*[b]	*M*[b]	*SD*[b]	*t*	*p* (< .05)	95% *CI* for Mean Difference
Mean RR	885.48	113.78	887.02	147.85	-0.036	0.972	-88.91, 91.36
STD RR	1.71	0.21	1.73	0.17	-0.325	0.747	-0.15, 0.11
Mean HR	69.39	8.98	69.89	11.21	-0.152	0.880	-7.24, 6.23
STD HR[a]	0.70	0.19	0.71	0.13	-0.351	0.728	-.13, 0.09
RMSSD[a]	47.61	21.30	53.81	29.35	-0.744	0.462	-23.15, 10.74
LF[a]	3.18	0.51	3.19	0.33	-0.075	0.941	-.30, 0.28
HF[a]	2.79	0.35	2.88	0.39	-0.763	0.450	-.34, 0.16
LF/HF[a]	0.36	0.36	0.39	0.39	0.671	0.507	-0.17, 0.33
PEFR[a]	2.67	0.09	2.67	0.10	0.045	0.964	-0.06, 0.06

Note. *M*= mean; *SD* = standard deviation; *t* = t statistic; *CI* = Confidence Interval. [a] signifies variable log 10 transformed. [b] values in these columns were rounded to the hundredth of a decimal. Results indicate no significant difference in Physiologic measures for experimental group when compared to control at baseline.

Table 4. *Results of Independent Samples t-test Comparing Post Intervention Physiologic Measures of Heart Rate Variability (HRV) and Peak Expiratory Flow Rate (PEFR) of the Experimental and Control groups*

	Experimental (n=20)		Wait-listed Control (n=21)				
Variable	*M*[b]	*SD*[b]	*M*[b]	*SD*[b]	*t*	*p* (< .05)	95% *CI* for Mean Difference
Mean RR	869.85	120.96	850.65	103.93	0.54	0.592	-52.79, 91.19
STD RR	49.78	21.77	51.97	18.13	-0.348	0.730	-14.98, 10.58
Mean HR	70.85	10.08	71.99	8.71	-0.382	0.705	-7.15, 4.88
STD HR[a]	0.67	0.17	0.74	0.24	-0.995	0.326	-0.20, 0.07
RMSSD[a]	1.56	0.212	1.61	0.18	-0.922	0.363	-0.18, 0.07
LF[a]	3.10	0.408	3.14	0.34	-0.304	0.762	-0.27, 0.20
HF[a]	2.65	0.45	2.79	0.40	-1.014	0.317	-0.41, 0.14
LF/HF[a]	0.45	0.34	0.35	0.44	0.813	0.421	-0.15, 0.36
Peak Flow[a]	2.71	0.08	2.69	0.09	0.749	0.459	-0.03, 0.07

Note. *M*= mean; *SD* = standard deviation; *t* = t statistic; *CI* = Confidence Interval. [a] signifies variable log 10 transformed. [b] values in these columns were rounded to the hundredth of a decimal. Results indicate no significant difference in Physiologic measures for experimental group when compared to control following intervention.

Table 5. *Results of Paired Samples t Test Comparing Pre and Post Intervention Physiologic Measures of Heart Rate Variability (HRV) and Peak Expiratory Flow Rate (PEFR) of Experimental and Control groups*

	Time Point 1			Time Point 2						
Variable Group	n T1	M[b]	SD[b]	N T2	M[b]	SD[b]	*df*	*t*	*p* (>.05)	95% CI for Mean Difference[b]
Mean RR										
Ex. Grp.	20	876.14	108.74	19	769.85	120.96	19	0.203	0.841	-58.80, 71.39
WLC [a]	17	2.94	0.07	21	2.93	0.05	17	0.657	0.521	-0.02, 0.04
STD RR										
Ex. Grp.[a]	19	1.72	0.21	19	1.66	0.18	19	3.111	0.006*	0.02, 0.10
WLC	17	57.13	20.58	17	50.91	14.40	17	1.012	0.327	-6.81, 19.25
Mean HR										
Ex. Grp.	19	70.07	8.69	19	70.85	10.08	19	-2.91	0.775	-6.46, 4.89
WLC[a]	17	69.89	11.21	17	70.93	8.39	17	-.431	0.672	-6.15, 4.07
STD HR										
Ex. Grp.	19	5.51	2.10	19	5.03	1.87	19	1.599	0.172	-0.15, 1.11
WLC[a]	17	0.71	0.13	17	0.74	0.26	17	-.586	0.566	-0.15, 0.09
RMSSD										
Ex. Grp.	19	48.21	21.71	19	40.62	22.05	19	2.494	0.023*	1.20, 13.98
WLC	20	53.81	29.35	17	41.32	9.42	17	1.998	0.063	-.76, 25.74
LF										
Ex. Grp.[a]	19	3.21	0.50	19	3.10	0.41	19	1.886	0.075	-0.01, 0.21
WLC [a]	17	3.19	0.33	17	3.17	0.33	17	0.106	0.917	-0.25, 0.27
HF										
Ex. Grp.[a]	19	2.80	0.36	19	2.65	0.45	19	2.378	0.029*	0.02, 0.27
WLC[a]	17	2.88	0.39	17	2.78	0.26	17	1.32	0.206	-0.06, 0.27
LF/HF										
Ex. Grp.[a]	19	0.41	0.35	19	0.45	0.34	19	-0.471	0.643	-0.23, 0.15
WLC[a]	17	0.30	0.39	17	0.39	0.41	17	-0.805	0.433	-0.33, 0.15
PEFR										
Ex. Grp.	20	482.5	96.77	20	523.5	88.92	20	-4.442	0.000*	-41.28, -21.68
WLC[a]	21	2.67	0.10	21	2.69	0.09	21	-1.046	0.308	-41.28, -21.68

Note. *M*= mean; *SD* = standard deviation; *t* = t statistic; Ex Grp = Experimental group; WLC = Wait-listed control group. *Indicates significant finding, $p \leq .05$. [a] signifies variable log 10 transformed. [b] values in these columns were rounded to the hundredth of a decimal. Results of within subjects analysis indicate three HRV measures with significant difference in scores for STD RR, RMSSD and HF, as well as for Peak Expiratory Flow Expiratory Flow Rate.

Table 6. *Results of Self-Report Measure Change Score Comparison of Experimental and Wait-Listed Control (WLC) Group*

Variable	***N***	***Md***	**Mann Whitney *U***	**Test Statistic (*Z*)**	***p* (< .05)**	**Effect Size (*r*)**
Positive Affect			147.5	-1.633	< .005*	.26
Experimental Group	20	25.5				
WLC Group	21	2				
SF 36 Role Emotional			147.5	-1.633	.046*	.26
Experimental Group	20	8.33				
WLC Group	21	-8.34				
SF 36 Mental Health			320.5	2.91	.033*	.45
Experimental Group	20	5				
WLC Group	21	0				
SF36 Physical Component Summary			100	-2.695	< .005*	.42
Experimental Group	20	-.27				
WLC Group	21	2.14				

Note. *N* = number of subjects in each group; *Z* = Z score; *Indicates significant finding, $p \leq .05$; *r*= measure of effect size, using Cohen (1988) criteria of .1 = small effect, .3 = medium effect, and .5 = large effect.

Table 7. *Results of Self-Report Measure Change Score Analysis*

Variable	***N***	**Test Statistic (*z*)**	***p* (<.05)**	**Observed Median**	**Effect Size (*r*)**	**% Score Change** Decrease / Increase
Perceived Stress Scale	41	.091	.928	0	.01	45% / 46%
Positive Affect Score	41	4.369	< .005*	11	.48	29% / 66%
Negative Affect Score	41	-1.789	.074	-1	.01	76% / 17%
PHQ 8 Score	41	-1.154	.248	0	.18	46% / 14%
SF 36 Role Physical Score	41	1.994	.046*	0	.22	17% / 32%
SF 36 General Health Score	41	2.137	.033*	5	.24	16% / 60%
SF36 Mental Composite Score	41	5.484	< .005*	12.9	.61	2% / 98%
Connor Davidson Resilience Scale	41	2.158	.031*	2	.24	27% / 66%

Note. Results of Wilcoxon Signed Rank analyses. N = number of subjects in each group; Z = Z score; *Indicates significant finding, $p \leq .05$; r= measure of effect size, using Cohen (1988) criteria of .1 = small effect, .3 = medium effect, and .5 = large effect.

Supplementary Table 1. *Results of Friedman's test of Measures of Heart Rate Variability and Peak Expiratory Flow Rate (PEFR) over six time points*

Measure	**T1**	**T2**	**T3**	**T4**	**T5**
	Baseline	Post LY1	Post LY2	Post LY3	Post LY4
	Md (IQR)	*Md (IQR)*	*Md (IQR)*	*Md (IQR)*	*Md (IQR)*
Mean RR	862.51 (791.46, 974.16)	907.1 (808.81, 967.76)	894.42 (842.08, 970.21)	902.26 (814.65, 985.76)	880.85 (813.94, 977.33)
STD RR	47.42 (36.98, 70.88)	44.01 (33.88, 62.45)	53.37 (37.32, 66.18)	51.5 (40.89, 62.97)	50.09 (42.87, 61.41)
Mean HR	70.76 (62.18,76.08)	66.96 (62.45, 74.49)	67.62 (62.04, 72.08)	67.0 (61.09, 74.76)	68.45 (61.66, 74.33)
STD HR	5 (3.99, 6.94)	4.16 (3.53, 5.65)	4.56 (3.38, 5.31)	4.68 (3.4, 5.55)	4.64 (3.71, 5.92)
RMSSD	41.69 (30.93,65)	43.07 (27.74, 61.45)	45.29 (34.94, 55.53)	44.81 (35.32, 57.71)	48.17 (37.84, 60.86)
LF	1,347.1 (752.05, 2,870.87)	1,186.05 (774.6, 2,282.43)	1,531.75 (854.11, 2931.18)	1,554.26 (846.53, 2,383.05)	1,134.93 (759.05, 1,904.78)
HF	665.35 (397.24, 1,340.91)	560.5 (261.09, 1,128.39)	509.47 (381.62, 1,022.63)	704.92 (415.58, 1,226.43)	801.88 (501.17, 1,274.78)
HF/LF Ratio	2.26 (1.1, 4.56)	2.29 (1.58, 4.24)	2.38 (1.68, 4.61)	2.32 (1.14, 3.45)	1.56 (0.78, 2.46)
PEFR	463 (407, 540)	317 (288, 388)	418 (382, 515)	402 (374, 479)	379 (348, 459)

Note. T = time point; LY = Laughter Yoga session; *Md* = median; IQR = Interquartile range, (25^{th} percentile, 75 percentile); *Indicates significant finding, $p < .05$.

Investigation of a Biobehavioral Intervention's Impact on Physiologic State, Perceived Stress, Affect, General Health and Resilience

Lt Col Jacqueline M. Killian

PhD Dissertation Defense

23 July 2015

Uniformed Services University
of the Health Sciences

Jonas Center
for Nursing and
Veterans Healthcare
Improving Healthcare Through Nursing

DISCLOSURE

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DISCLAIMER

The opinions or assertions contained herein are the private views of the author and are not to be construed as reflecting the official policy or position of the Uniformed Services University of the Health Sciences, the Department of Defense or the United States government.

Agenda

- Background & Significance
- Specific Aims
- Methods
- Results
- Conclusions
- Acknowledgments
- Questions

Background & Significance

- Stress
- Theoretical Framework
- Intervention ~ Laughter Yoga

How Stress Impacts the Military

- 27.4% active duty Air Force personnel reported significant job stress (Pflanz & Ogle, 2006)
  - Nearly half c/o symptoms of depression
  - Two thirds of work stress adversely affecting physical health

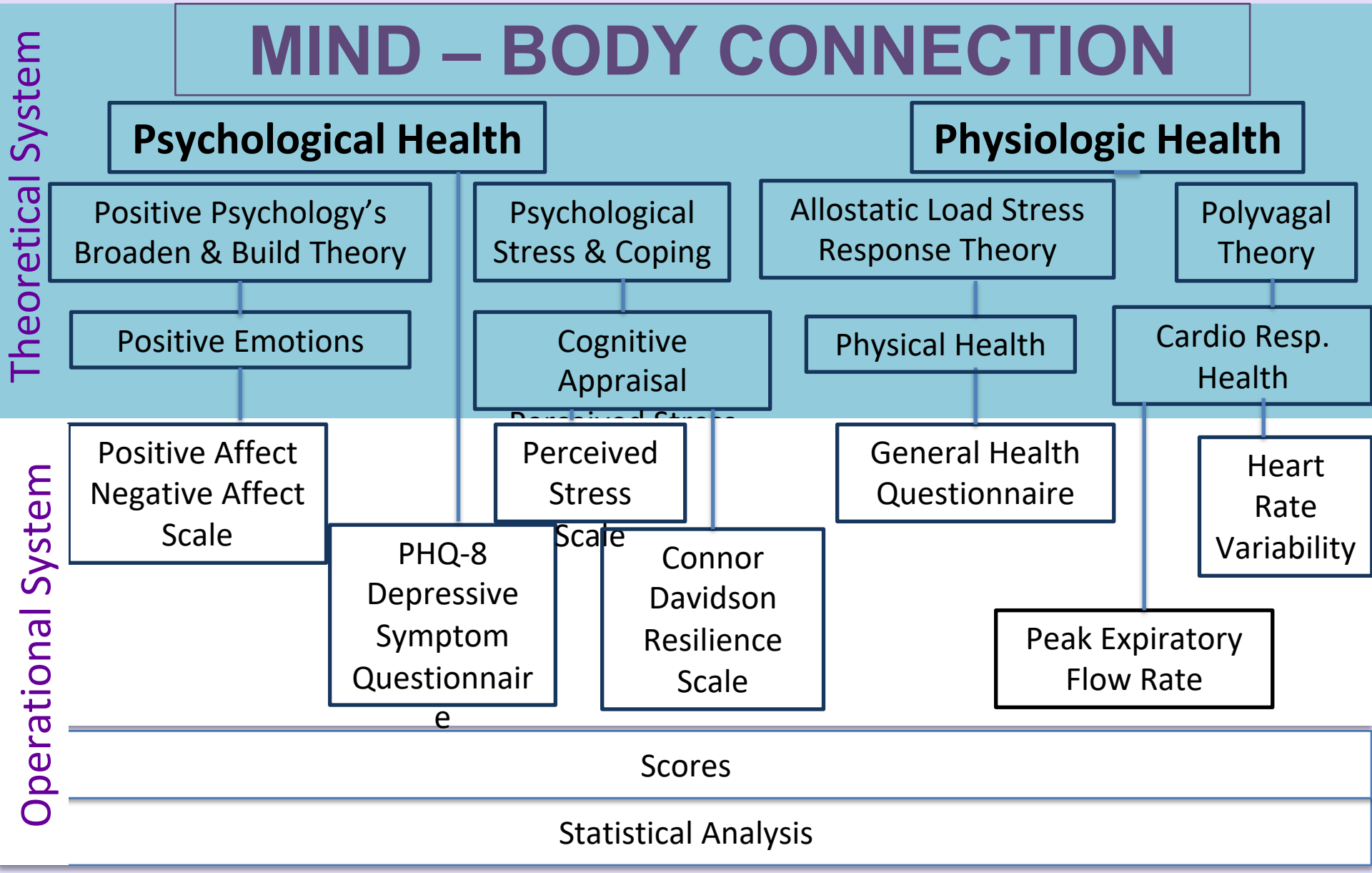
- Military healthcare professionals at risk for secondary traumatic stress (STS) (Kintzle, Yarvis, & Bride 2013)

How Stress Impacts the Military

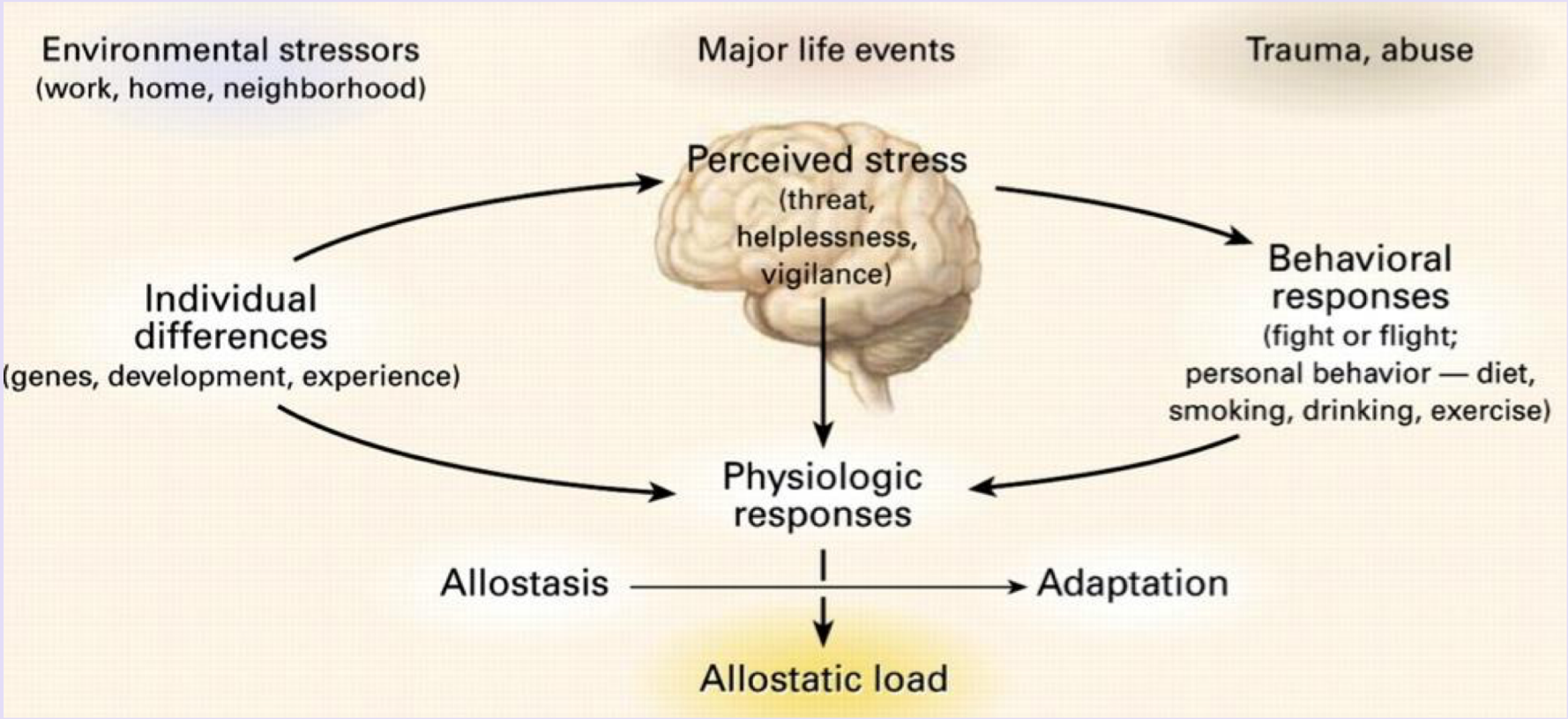
- DoD Health Related Behavior Survey
  - 2002: higher levels of stress at work than in family life for active duty personnel of all military branches
  - 2008: Greater than 25% describe military duties as stressful
  - 2011: Devote an entire chapter to stress and mental health; over 40% report separation from family and changes in workload as leading causes of stress; 16.7% report high levels of anxiety; 10% report a high depression level

- 2014 Medical Surveillance Monthly Report annual summary results
  - Mental health disorders accounted for most hospital days (44%); 18.8% medical encounters and 21.7% of lost work time

Theoretical Framework



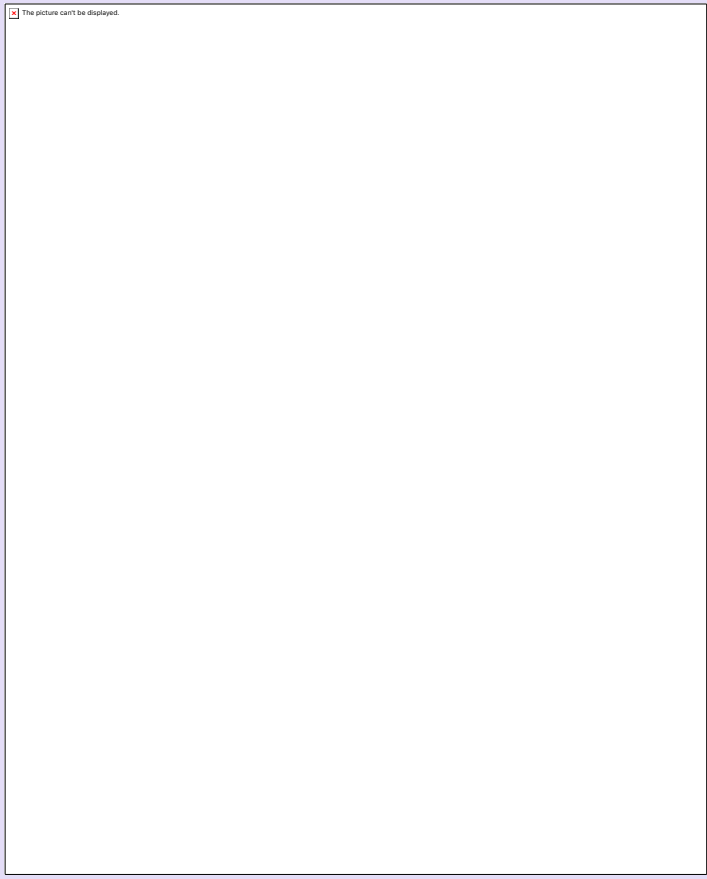
Allostatic Load Stress Response Theory



Central role of the brain in allostasis and the behavioral and physiological response to stressors. [From McEwen (2011), copyright 1998 Massachusetts Medical Society.]

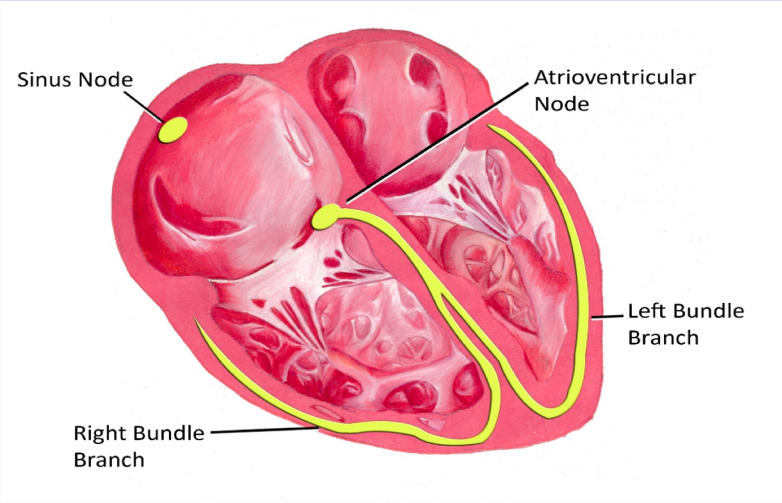
Polyvagal Theory

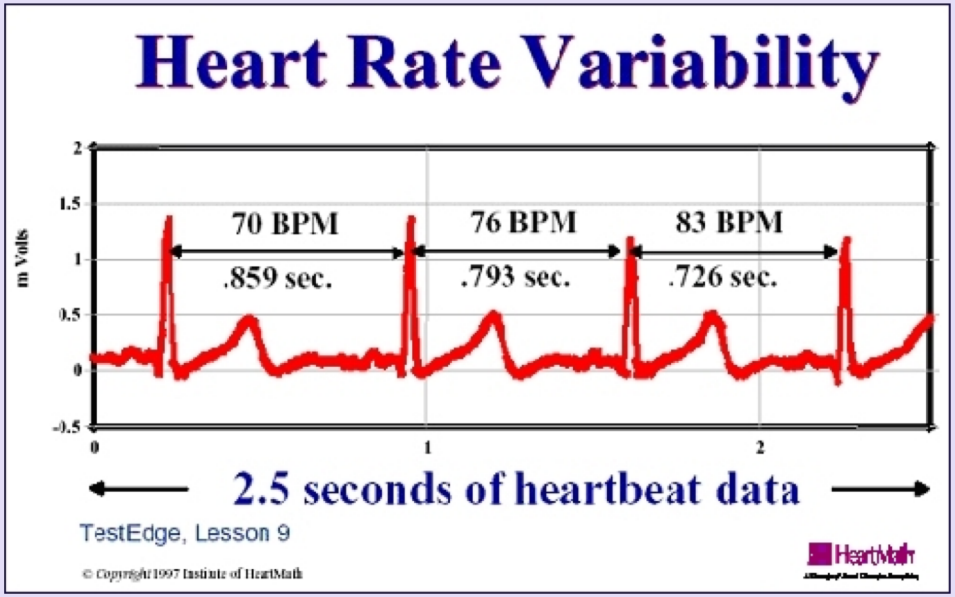
- Vagal system includes fibers that regulate:
  - Smooth & cardiac muscle
  - Muscles of larynx, pharynx, esophagus
  - Linked to control of facial muscles
- 2 vagal motor systems
  - Vegetative Vagus = freeze
  - Smart Vagus = attention motion, emotion & communication
- Vagal branch originating in nucleus ambiguus and terminating on sinoatrial node impacts cardio-respiratory systems



(Porges, 1995,2001)

Heart Rate Variability

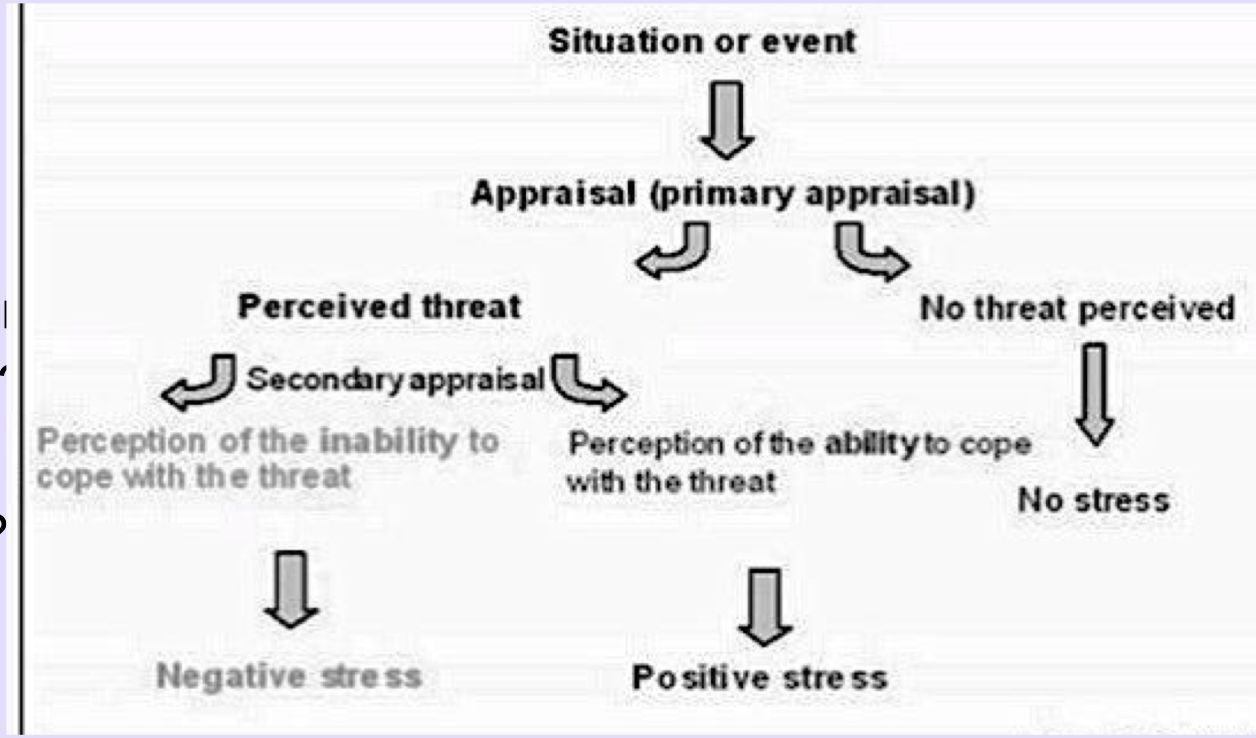




- Intrinsic Heart Rate = 60 to 100 bpm
- Sympathetic activation
- Parasympathetic activation
- HRV: means of measuring autonomic nervous system response (Brierley-Bowers, Sexton, Brown, & Bates, 2011)
- Captured via 3 lead ECG
- ECG waveform elicits QRS complex & R-to-R interval or inter beat interval (IBI)
- Algorithmically analyzed to compute HRV from IBI series data (Allen, Chambers, & Towers, 2007)

Psychological Stress & Coping Theory

- **Cognitive Appraisal**
  (Perception)
  - Individual evaluatio
  - Is stressor relevant
  - In what way?
  - What can be done?



(Lazarus & Folkman, 1985,1988)

- **Coping**
  Changing cognitive / behavioral efforts to manage external / internal demands of resources
  Positive affect during periods of chronic stress help with coping

Broaden and Build Theory

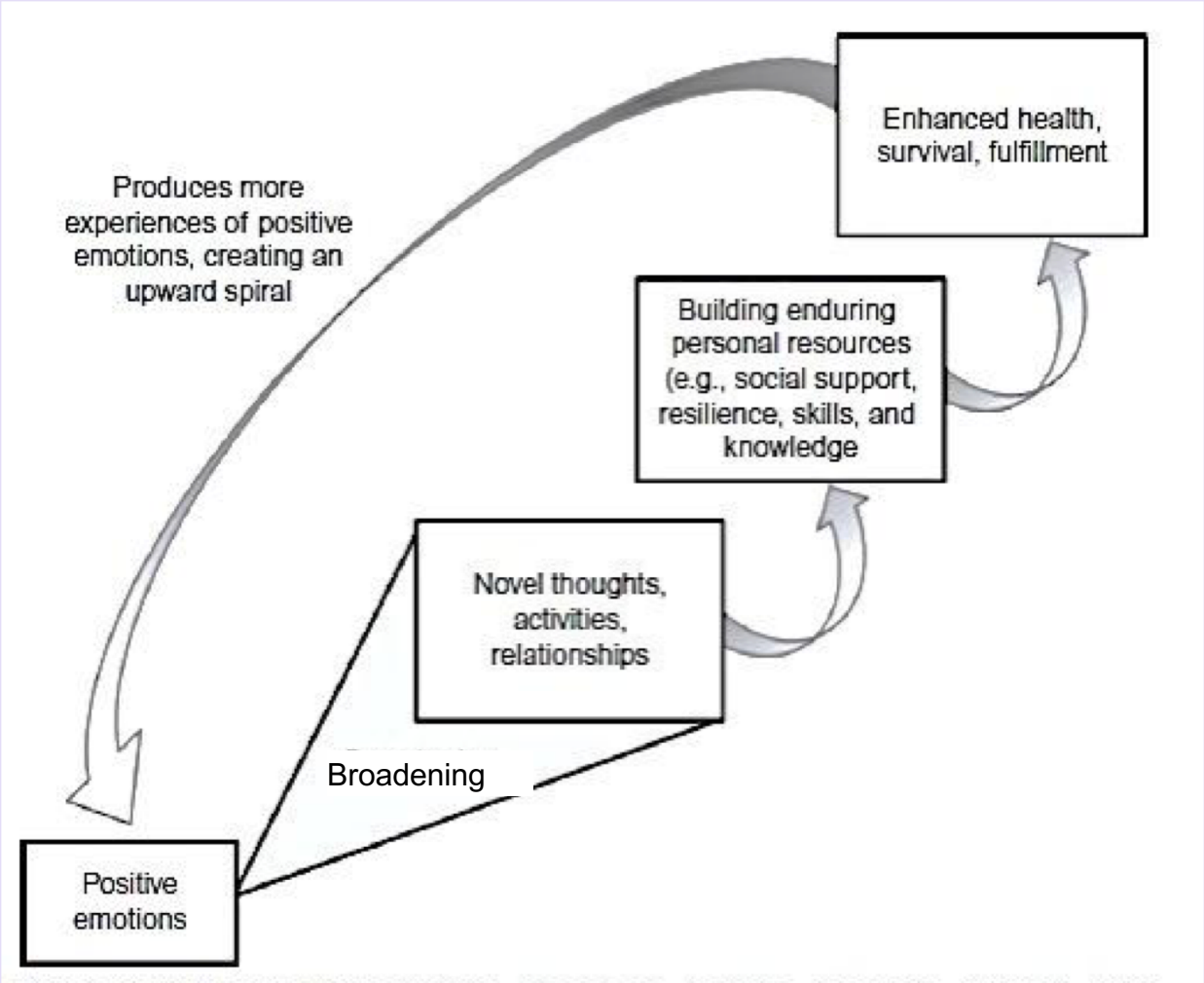
Positive Emotions

Broaden:

- Scope of cognition (Isen, 1985)
- Momentary thought-action cognitive pathways

Build:

- Personal resources
- Fuel psychological resilience



Problem

High levels of stress lead to physical and mental health sequella which negatively impact productivity and the ability to accomplish the mission.

New, innovative treatment options are needed.

Biobehavioral Intervention

Laughter Yoga

- Form of yogic breath work
- Ha Ho sounds with exhalation
- Chanting and deep slow breaths
- Accomplished in group setting

Health Benefits of Mirthful Laughter

Physiologic

- ? Blood Pressure (Fry, 1988)
- ? Serum Cortisol and Other Biochemicals Associated with the Stress Response(Berk & Fry, 1989)
- ? Natural Killer T cells (Berk, et.al., 2001; Bennett, Zeller, Rosenberg & McCann, 2003)
- ?Brachial Arterial Flow Rate (Miller & Fry, 2009)

Psychological

- ? Stress (Bennett, Zellar Rosenberg, & McCann, 2003)

Health Benefits of Laughter Yoga

Physiologic

- Blood Pressure, Salivary Cortisol and Amylase (Nagendra, et.al., 2007; Nkamichi, et.al., 2013)
- Heart Rate Variability, Mobility (Dolgoff-Kaspar, et.al., 2012; Keykhahosei, et.al., 2013)

Psychological

- Stress, Negative Affect, Anxiety, Depression (Nagendra, et.al., 2007; Weinberg, et.al., 2013; Shahidi, et.al., 2010; Nalini, et.al., 2014; Farifteh, et.al., 2014;)
- Mood, Positive Affect, Self-Efficacy, Self-Regulation, Optimism, Positive Emotions and Social Identification and Life Satisfaction (Beckman, Regier & Young, 2007; Shahidi, et.al., 2010; Dolgoff-Kaspar, et.al., 2012)

HRV and Peak Expiratory Flow Rate: Metrics for the Physiologic Effect of LY

- Slow deep breathing & diaphragmatic activity stimulates the parasympathetic nervous system
- Controlled breathing has been shown to affect the autonomic nervous system and heart rate variability
- Slow deep breathing work enhances parasympathetic nervous system activity, increases vagal tone and heart rate variability
- **LY causes changes** in breathing pattern due to laughter and interspersed deep slow breath work

(Jerath, et. al.,2006; Moore, et. al., 2011)

Purpose

The purpose of this pilot investigation is to examine the impact of the biobehavioral intervention, laughter yoga, on:

cardiac reactivity
respiratory status
perceived stress
affect
general health and resilience
in a military graduate student sample.

AIMS

Specific Aim 1

Explore the impact of LY on the physiologic measures of heart rate variability and peak expiratory flow rate.

RQ1. Which if any of the physiologic parameters (HRV or peak expiratory flow measurement) is most responsive to LY?

RQ2. Will repeated practice of LY result in continued increased HRV and peak flow?

Specific Aim 2

Explore the impact of LY on participants' perceived stress, affect, general health and resilience.

RQ1. Will there be a difference in scores when conducting between groups comparison of intervention group to control in terms of scores obtained from the self report measures?

RQ2. Will there be a difference in scores when conducting within group comparison of pre and post intervention measures in terms of scores obtained from the self report measures?

Specific Aim 3

Describe the participant's experience of engaging in LY.

RQ1. How will participants characterize and describe their laughter yoga experience?

METHODS

Design

Quasi experimental pretest posttest wait-listed group design

	T 1	Wk 1	Wk 2	T 2	Wk 3	Wk 4	T 3
	Baseline			Mid-Study			End of Study
Experimental Group	X	LY	LY	X	___	___	X
Wait-listed Control (WLC) Group	X	___	___	X	LY	LY	X

X = Measurement Point
LY = Laughter Yoga

Human Subjects Protection

- USUHS IRB review and approval
- Informed consent
- Mental Health resources provided at each session

Power Analysis

A priori power analysis using SAS v.9.3 for

- n = 15 (between groups comparison)
  - Independent Samples *t* test, Cohen's *d* of 1.0, power .78, alpha .05
- n = 30 (within-subjects comparison)
  - Paired Sample *t* test Cohen's *d* of .75, power .80, alpha .05
- Target group recruitment = 25 participants/group

SAS version 9.3 for Windows (Copyright (c) 2002-2010 by SAS Institute Inc., Cary, NC, USA)

Sample Selection

- **Inclusion criteria:**
  - USUHS graduate students
  - 20-50 years of age
  - Graduation date after September 2015
- **Recruitment**
  - Team approach
  - Email, Facebook, Flyers, Word of Mouth
  - Information Tables

- **Exclusion criteria:**
  - Hernia
  - Severe backache
  - Heart disease with history of angina
  - Uncontrolled high blood pressure
  - Persistent cough with breathlessness
  - Urinary incontinence
  - Advanced piles or hemorrhoids
  - Epilepsy

Laughter Yoga Leader Credentials

Trained with Dr. Madan Kataria received certification as Laughter Yoga Teacher November 2013

Intervention Period

- 2 LY session / week X 2 weeks = 4 sessions
- Scripted sessions
- Same session format for all sessions
  - Sign in
  - Pre session survey & peak flow rate
  - 5 minutes seated
  - 10 minutes HRV data collection
  - 3 part LY program
  - 10 minutes HRV data collection for HRV
  - Post session survey & peak flow rate

Study Data Collection

Main Study Measurement Sessions

T 1

10 Oct 2014

Demographics
Perceived Stress Scale
PANAS
PHQ8
SF 36
CD-RISC

10 minutes HRV data
3 peak flow measures

T 2

28 Oct 2014

Perceived Stress Scale
PANAS
PHQ8
SF 36
CD-RISC
Open Ended Questions

10 minutes HRV data
3 peak flow measures

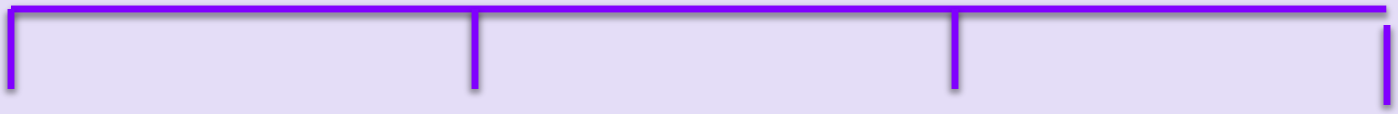
T 3

10-14 Nov 2014

Perceived Stress Scale
PANAS
PHQ8
SF 36
CD-RISC
Open Ended Questions

10 minutes HRV data
3 peak flow measures

Session Data Collection



1st Laughter Yoga Session | **2nd Laughter Yoga Session** | **3rd Laughter Yoga Session** | **4th Laughter Yoga Session**

LY Group	1st LY Session	2nd LY Session	3rd LY Session	4th LY Session
A	T 10/14*	Th 1016	T 10/21	Th 10/23
B	W 10/15	M 10/20	W 10/22	M 10/27
C	W 10/29	M 11/3	W 11/5	F 11/7**
D	Th 10/30	T 11/4	Th 11/6	W 11/12**

- Pre and Post Session Laughter Yoga Surveys
- Pre and Post peak flows (3) collected
- Pre and Post Session 10 minutes HRV data collected

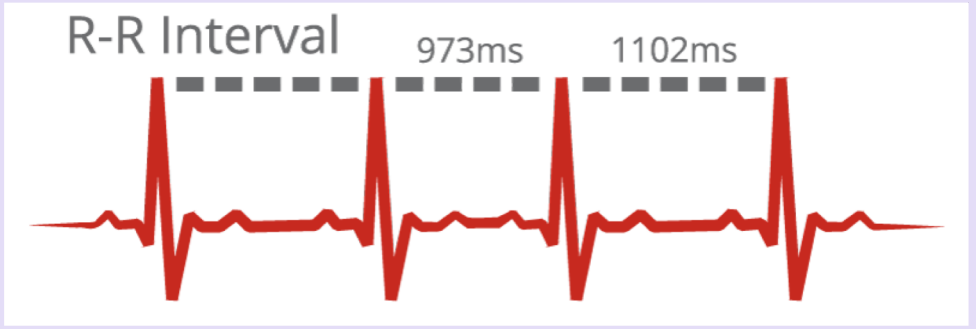
Schedule altered due to *Columbus Day & **Veteran's Day holiday

Data Collection

Physiologic Measures

- Heart rate and Heart Rate Variability





Killian, Radin, Gardner, Kasuske, Bashirelahi, Nathan, Keyser, & Rapp (2014) Low Cost Alternative Devices for Heart Rate Variability Measures: A Test-Retest Reliability Study. (Publication in review by Psychophysiology)

Data Collection

Physiologic Measures

- Peak Expiratory Flow Rate (PEFR)
- 3 PEFR documented at each measurement time-point and before and after each session



Self Report Instrument Reliability & Validity

Instrument	Construct	Reliability & Validity (Cronbach's alpha)	Uses
Perceived Stress Scale	Perceived Stress	.76	Student, Adult & Patient Populations
Positive Affect Negative Affect Scale	Affect	.89 for PA .85 for NA	Student, Adult & Patient Populations
PHQ8	Psychological Health Symptoms of Depression	.89	Adult Primary Care
SF 36	General Health	.63-.93	General & Specific Populations
Connor Davidson Resilience Scale	Resilience	.89	General Populations & Clinical Samples

Qualitative Self Report

Open Ended Questions

1. Describe today's laughter yoga session in about 140 characters or less (like a tweet)
2. List any feelings that you are aware of now that today's laughter yoga session has ended.
3. List any sensations you are aware of now that today's laughter yoga session has ended.
4. Describe how participation in laughter yoga affected you and those around you during the two weeks you were attending sessions.

ECG Data Management for Extricating HRV Measures

1. Upload ECG data from emWave 2(HeartMath LLC) devices into HeartMath (HM) software on laptop
2. Convert HM files to txt files
3. Prepare txt files for Kubios
4. Analyze prepared txt files with Kubios program to obtain HRV indices
5. Use Matlab(Mathworks Inc.) computing software to populate Excel(Microsoft Inc.) spreadsheet for further analysis

(Tarvainen, & Niskanen, 2008)

HRV Measures

Time Domain measures

- Mean RR – the mean of the R to R intervals
- STD RR – the standard deviation of the R to R intervals
- RMSSD – square root of the mean squared differences between successive RR intervals

Frequency-domain measures

- LF – Low frequency band (0.04 – 0.15 Hz)
- HF – High frequency band (0.15 – 0.4 Hz)
- HF/LF Ratio – ratio between LF & HF band powers

(Tarvainen, & Niskanen, 2008)

Data Analysis

- Physiologic data
  - Independent Samples and Paired *t* test
  - Repeated Measures ANOVA
- Self Report Scores
  - Mann-Whitney U
  - Wilcoxon Signed Rank
- Participant Open Responses
  - Content Analysis

Conducted quantitative analysis using SPSS version 22 (IBM Corp)

RESULTS

Sample Size

- 43 USUHS military graduate students volunteered
  - A total of 41 participants completed the study
  - Random assignment to Experimental vs Control affected for those involved in Bushmaster; simple random assignment for subgroup
  - Experimental Group n = 20
  - Wait-listed Control Group n = 21

Sample Characteristics

Demographic Data (n=41)		
Mean Age	31	Range (22-52)
Male	15	37%
Female	26	63%
Academic Program		
School of Medicine	24	59%
Graduate School Nursing	13	32%
Biomed Sci/Med-Clin Psy/	4	9%
Branch of Service		
Air Force	14	34%
Army	11	27%
Navy	15	37%
Public Health	1	2%

Research Aim 1

Explore the impact of LY on physiologic parameters: measures of heart rate variability and peak expiratory flow rate.

Results: Physiologic Measures

Baseline Independent *t* Test Results:

Results of Independent Samples t test Comparing Pre Intervention Physiologic Measures of Heart Rate Variability (HRV) and Peak Expiratory Flow Rate (PEFR) by group at baseline

	Experimental (n=20)		Wait-listed Control (n=21)				
Variable	*M*[b]	*SD*[b]	*M*[b]	*SD*[b]	*t*	*p* (< .05)	95% *CI* for Mean Difference
Mean RR	885.48	113.78	887.02	147.85	-0.036	0.972	-88.91, 91.36
STD RR	1.71	0.21	1.73	0.17	-0.325	0.747	-0.15, 0.11
Mean HR	69.39	8.98	69.89	11.21	-0.152	0.880	-7.24, 6.23
STD HR[a]	0.70	0.19	0.71	0.13	-0.351	0.728	-.13, 0.09
RMSSD[a]	47.61	21.30	53.81	29.35	-0.744	0.462	-23.15, 10.74
LF[a]	3.18	0.51	3.19	0.33	-0.075	0.941	-.30, 0.28
HF[a]	2.79	0.35	2.88	0.39	-0.763	0.450	-.34, 0.16
LF/HF[a]	0.36	0.36	0.39	0.39	0.671	0.507	-0.17, 0.33
PEFR[a]	2.67	0.09	2.67	0.10	0.045	0.964	-0.06, 0.06

Note. *M*= mean; *SD* = standard deviation; *t* = t statistic; *CI* = Confidence Interval. [a] signifies variable log 10 transformed. [b] values in these columns were rounded to the hundredth of a decimal. Results indicate no significant difference in physiologic measures for experimental group when compared to control at baseline.

Results: Physiologic Measures

Post Intervention Independent *t* Test Results

Results of Independent Samples t-test Comparing Post Intervention Physiologic Measures of Heart Rate Variability (HRV) and Peak Expiratory Flow Rate (PEFR) of the Experimental and Control groups

	Experimental (n=20)		Wait-listed Control (n=21)				
Variable	*M*[b]	*SD*[b]	*M*[b]	*SD*[b]	*t*	*p* (< .05)	95% *CI* for Mean Difference
Mean RR	869.85	120.96	850.65	103.93	0.54	0.592	-52.79, 91.19
STD RR	49.78	21.77	51.97	18.13	-0.348	0.730	-14.98, 10.58
Mean HR	70.85	10.08	71.99	8.71	-0.382	0.705	-7.15, 4.88
STD HR[a]	0.67	0.17	0.74	0.24	-0.995	0.326	-0.20, 0.07
RMSSD[a]	1.56	0.212	1.61	0.18	-0.922	0.363	-0.18, 0.07
LF[a]	3.10	0.408	3.14	0.34	-0.304	0.762	-0.27, 0.20
HF[a]	2.65	0.45	2.79	0.40	-1.014	0.317	-0.41, 0.14
LF/HF[a]	0.45	0.34	0.35	0.44	0.813	0.421	-0.15, 0.36
Peak Flow[a]	2.71	0.08	2.69	0.09	0.749	0.459	-0.03, 0.07

Note. *M*= mean; *SD* = standard deviation; *t* = t statistic; *CI* = Confidence Interval. [a] signifies variable log 10 transformed. [b] values in these columns were rounded to the hundredth of a decimal. Results indicate no significant difference in physiologic measures for experimental group when compared to control following intervention.

Results: Physiologic Measures

Paired *t* Test Results

HRV measures

- STD RR (p = .006)
- RMSSD (p = .023)
- HF (p = .029)

Peak Flow (p < .001)

Results of Paired Samples t Test Comparing Pre and Post Intervention Physiologic Measures of Heart Rate Variability (HRV) and Peak Expiratory Flow Rate (PEFR) of Experimental and Control groups

Variable / Group	Time Point 1 n T1	Time Point 1 M[b]	Time Point 1 SD[b]	Time Point 2 N T2	Time Point 2 M[b]	Time Point 2 SD[b]	*df*	*t*	*p* (<.05)	95% CI for Mean Difference[b]
Mean RR										
Ex. Grp.	20	876.14	108.74	19	769.85	120.96	19	0.203	0.841	-58.80, 71.39
WLC [a]	17	2.94	0.07	21	2.93	0.05	17	0.657	0.521	-0.02, 0.04
STD RR										
Ex. Grp.[a]	19	1.72	0.21	19	1.66	0.18	19	3.111	0.006*	0.02, 0.10
WLC	17	57.13	20.58	17	50.91	14.40	17	1.012	0.327	-6.81, 19.25
Mean HR										
Ex. Grp.	19	70.07	8.69	19	70.85	10.08	19	-2.91	0.775	-6.46, 4.89
WLC[a]	17	69.89	11.21	17	70.93	8.39	17	-.431	0.672	-6.15, 4.07
STD HR										
Ex. Grp.	19	5.51	2.10	19	5.03	1.87	19	1.599	0.172	-0.15, 1.11
WLC[a]	17	0.71	0.13	17	0.74	0.26	17	-.586	0.566	-0.15, 0.09
RMSSD										
Ex. Grp.	19	48.21	21.71	19	40.62	22.05	19	2.494	0.023*	1.20, 13.98
WLC	20	53.81	29.35	17	41.32	9.42	17	1.998	0.063	-.76, 25.74
LF										
Ex. Grp.[a]	19	3.21	0.50	19	3.10	0.41	19	1.886	0.075	-0.01, 0.21
WLC [a]	17	3.19	0.33	17	3.17	0.33	17	0.106	0.917	-0.25, 0.27
HF										
Ex. Grp.[a]	19	2.80	0.36	19	2.65	0.45	19	2.378	0.029*	0.02, 0.27
WLC[a]	17	2.88	0.39	17	2.78	0.26	17	1.32	0.206	-0.06, 0.27
LF/HF										
Ex. Grp.[a]	19	0.41	0.35	19	0.45	0.34	19	-0.471	0.643	-0.23, 0.15
WLC[a]	17	0.30	0.39	17	0.39	0.41	17	-0.805	0.433	-0.33, 0.15
PEFR										
Ex. Grp.	20	482.5	96.77	20	523.5	88.92	20	-4.442	0.000*	-41.28, -21.68
WLC[a]	21	2.67	0.10	21	2.69	0.09	21	-1.046	0.308	-41.28, -21.68

Note. *M*= mean; *SD* = standard deviation; *t* = t statistic; Ex Grp = Experimental group; WLC = Wait-listed control group. *Indicates significant finding, $p \leq .05$. [a] signifies variable log 10 transformed. [b] values in these columns were rounded to the hundredth of a decimal. Results of within subjects analysis indicate two HRV measures with significant difference in scores for STD RR, and HF as well as for Peak Expiratory Flow Expiratory Flow Rate.

Results: Physiologic Measures

- Friedman's two way analysis of variance by ranks with pairwise comparison with Bonferonni correction for multiple comparisons over 6 time points

T1	T2	T3	T4	T5	T6
Baseline	LY1	LY2	LY3	LY4	Post Intervention

Results: Physiologic Measures

- Friedman's test results:

Results of Friedman's test of Measures of Heart Rate Variability and Peak Expiratory Flow Rate (PEFR) over six time points

Measure	T1 Baseline *Md (IQR)*	T2 Post LY1 *Md (IQR)*	T3 Post LY2 *Md (IQR)*	T4 Post LY3 *Md (IQR)*	T5 Post LY4 *Md (IQR)*	T6 End of Intervention Period *Md (IQR)*	*p* (<.05)
Mean RR	862.51 (791.46, 974.16)	907.1 (808.81, 967.76)	894.42 (842.08, 970.21)	902.26 (814.65, 985.76)	880.85 (813.94, 977.33)	871.88 (778.34, 918.32)	.123
STD RR	47.42 (36.98, 70.88)	44.01 (33.88, 62.45)	53.37 (37.32, 66.18)	51.5 (40.89, 62.97)	50.09 (42.87, 61.41)	45.93 (39.17, 60.84)	.256
Mean HR	70.76 (62.18,76.08)	66.96 (62.45, 74.49)	67.62 (62.04, 72.08)	67.0 (61.09, 74.76)	68.45 (61.66, 74.33)	69.3 (65.95, 77.53)	.110
STD HR	5 (3.99, 6.94)	4.16 (3.53, 5.65)	4.56 (3.38, 5.31)	4.68 (3.4, 5.55)	4.64 (3.71, 5.92)	4.89 (3.9, 6.27)	.015*
RMSSD	41.69 (30.93,65)	43.07 (27.74, 61.45)	45.29 (34.94, 55.53)	44.81 (35.32, 57.71)	48.17 (37.84, 60.86)	38.54 (27.85, 50.7)	.283
LF	1,347.1 (752.05, 2,870.87)	1,186.05 (774.6, 2,282.43)	1,531.75 (854.11, 2931.18)	1,554.26 (846.53, 2,383.05)	1,134.93 (759.05, 1,904.78)	1,223.78 (843.87, 2,150.49)	.779
HF	665.35 (397.24, 1,340.91)	560.5 (261.09, 1,128.39)	509.47 (381.62, 1,022.63)	704.92 (415.58, 1,226.43)	801.88 (501.17, 1,274.78)	536.4 (305.92, 904.15)	.089
HF/LF Ratio	2.26 (1.1, 4.56)	2.29 (1.58, 4.24)	2.38 (1.68, 4.61)	2.32 (1.14, 3.45)	1.56 (0.78, 2.46)	2.69 (1.21, 3.89)	.083
PEFR	463 (407, 540)	317 (288, 388)	418 (382, 515)	402 (374, 479)	379 (348, 459)	480 (450, 583)	< .001*

Note. T = time point; LY = Laughter Yoga session; *Md* = median; IQR = Interquartile range, (25th percentile, 75 percentile);
*Indicates significant finding, $p \leq .05$.

Research Aim 2

Explore the impact of LY on participants' perceived level of stress, affect, general health and resilience.

Results: Self Report Measures

Mann Whitney U Results

Results of Self-Report Measure Change Score Comparison of Experimental and Wait-Listed Control (WLC) Group

Variable	*N*	*Md*	Mann Whitney *U*	Test Statistic (*Z*)	*p* (<.05)	Effect Size (*r*)
Positive Affect			147.5	-1.633	< .005*	.26
Experimental Group	20	25.5				
WLC Group	21	2				
SF 36 Role Emotional			147.5	-1.633	.046*	.26
Experimental Group	20	8.33				
WLC Group	21	-8.34				
SF 36 Mental Health			320.5	2.91	.033*	.45
Experimental Group	20	5				
WLC Group	21	0				
SF36 Physical Component Summary			100	-2.695	< .005*	.42
Experimental Group	20	-.27				
WLC Group	21	2.14				

Note. Results of Mann Whitney *U* analyses. *N* = number of subjects in each group; Z = Z score; *Indicates significant finding, $p \leq .05$; *r*= measure of effect size, using Cohen (1988) criteria of .1 = small effect, .3 = medium effect, and .5 = large effect.

Results: Self Report Measures

Wilcoxon Signed Rank Test Results

Results of Self-Report Measure Change Score Analysis

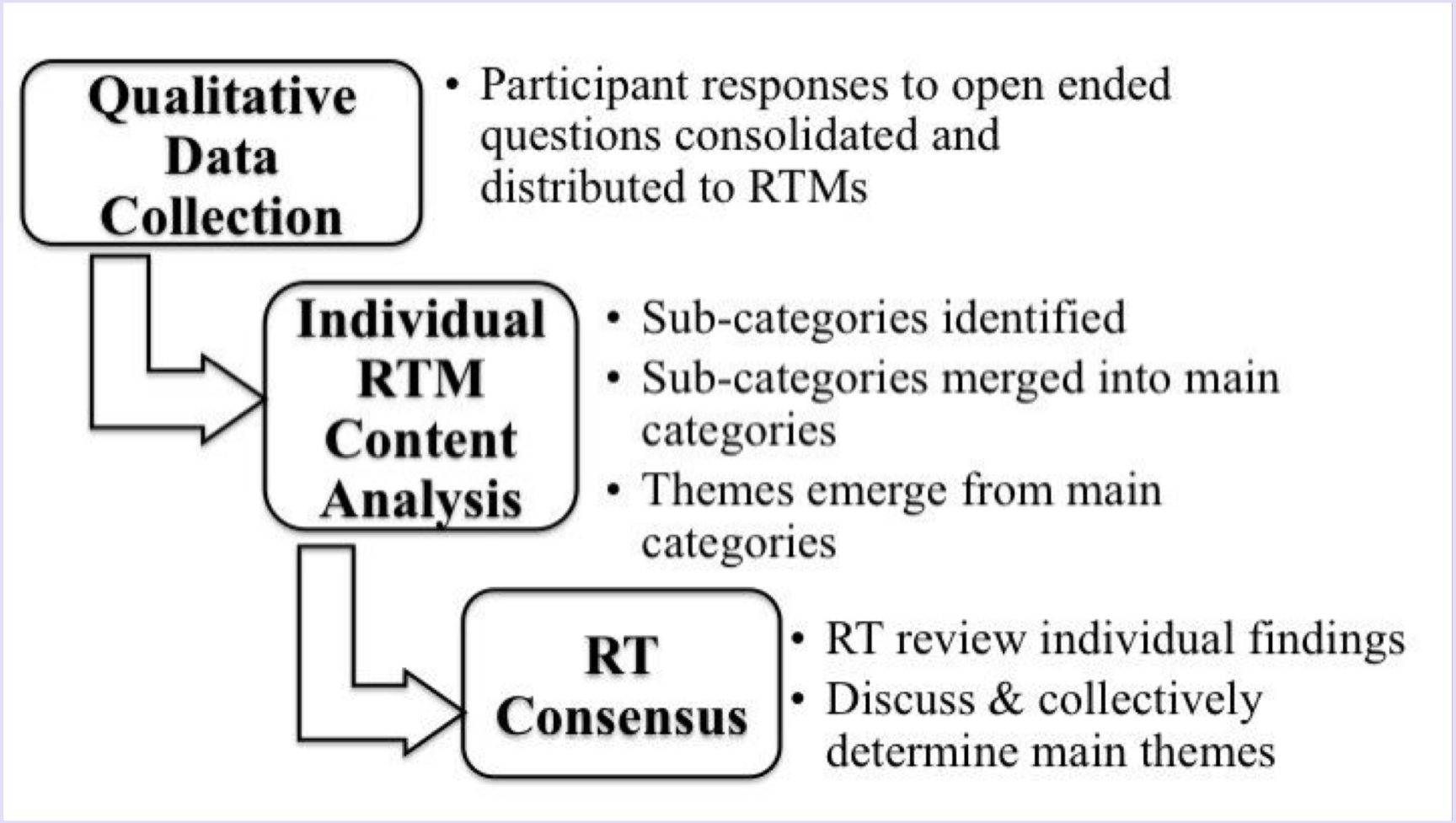
Variable	*N*	Test Statistic (*z*)	*p* (<.05)	Observed Median	Effect Size (*r*)	% Score Change Decrease / Increase
Perceived Stress Scale	41	.091	.928	0	.01	45% / 46%
Positive Affect Score	41	4.369	< .005*	11	.48	29% / 66%
Negative Affect Score	41	-1.789	.074	-1	.01	76% / 17%
PHQ 8 Score	41	-1.154	.248	0	.18	46% / 34%
SF 36 Role Physical Score	41	1.994	.046*	0	.22	17% / 32%
SF 36 General Health Score	41	2.137	.033*	5	.24	16% / 60%
SF36 Mental Composite Score	41	5.484	< .005*	12.9	.61	2% / 98%
Connor Davidson Resilience Scale	41	2.158	.031*	2	.24	27% / 66%

Note. Results of Wilcoxon Signed Rank analyses. N = number of subjects in each group; Z = Z score; *Indicates significant finding, $p \leq .05$; r= measure of effect size, using Cohen (1988) criteria of .1 = small effect, .3 = medium effect, and .5 = large effect.

Research Aim 3

Describe the participant's experience of engaging in LY.

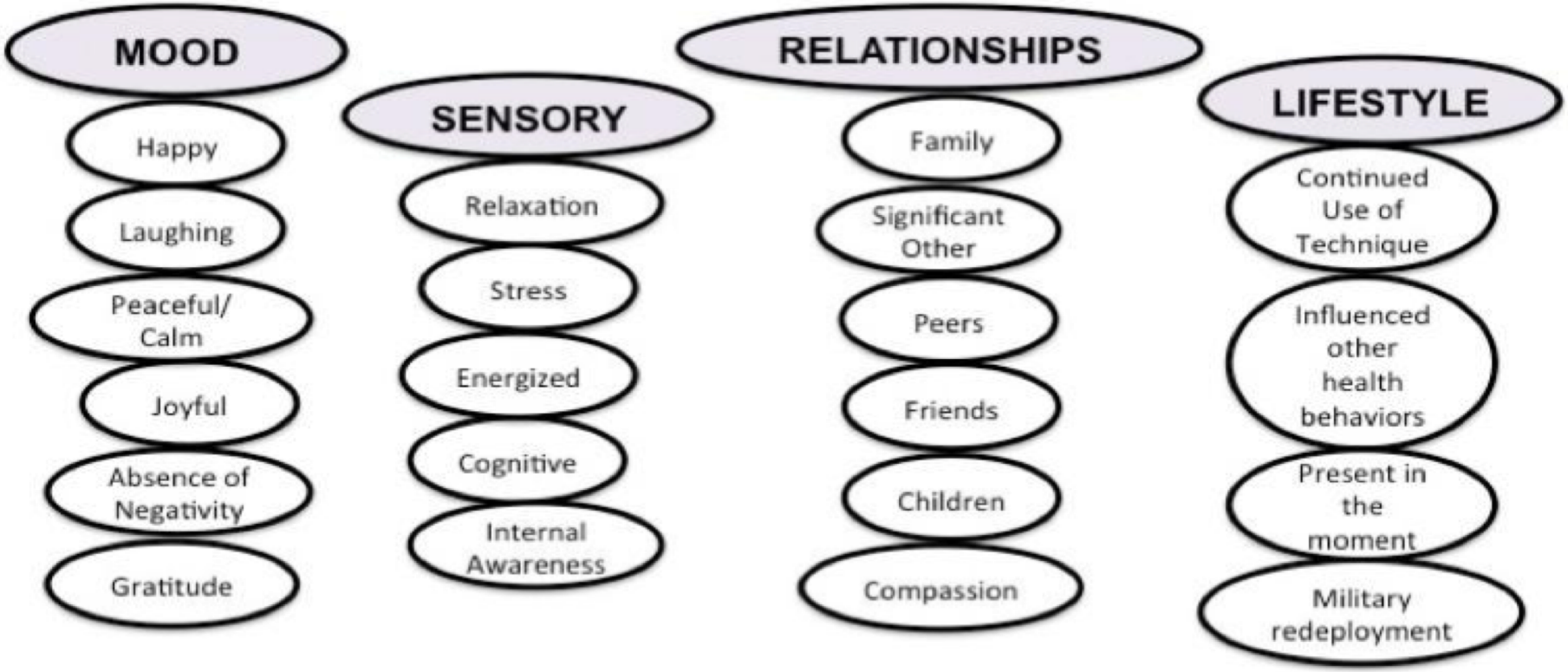
Content Analysis Process



RTM = Research Team Member
RT = Research Team

Results: Content Analysis of Participant Responses

Themes and Subthemes from Participant Responses Regarding the Impact of Laughter Yoga



Note. Main themes depicted in upper most touchstone shape with shaded background, subthemes of each main theme listed below each. Themes and subthemes derived from participant responses regarding how they were affected by participation in laughter yoga.

Participant Responses

- “Happy, joyful, optimistic.”
- “So much more relaxed and less stressed. I felt like I could better handle all of the things I have to do and study for school. I also felt extremely happy- it was very cathartic.”
- “Yes, noticed when I start feeling stress I smile, take a deep breath in and continue on in the "stressed" environment with a more relaxed attitude.”

Participant Responses

“As an introvert, it is difficult to "put myself out there". I think these sessions gave me an experience to help me personally deal with larger groups that I am unfamiliar with. I think this would have been a great experience for me during my redeployment reintegration after my Afghanistan tour.”

Participant Responses

“I have started exercising more, I am eating better, I have stopped drinking alcohol, I drink less coffee, I sleep sounder/more and I am able to focus better. I think laughter yoga allowed me to think about my daily habits and compare the outcomes/consequences of my actions to the feeling I have following a LY session, thus I have made a few changes in my routines.”

Key Findings

Aim 1- Physiologic Measures

- LY participation significantly decreased measures of HRV:

(STD RR, p=.006; RMSSD, p=.023; HF p=.029)

  - Stimulating effect of activity
  - Continued investigation needed to ascertain most effective timing of HRV measurement

- LY participation significantly increased PEFR p=<.001

Key Findings

Aim 2- Self Report Measures

- LY participation significantly increased
  - Positive Affect (p = .005)
  - General Health subscales
    - Role Emotional (p = .046)
    - Role Physical (p = .046)
    - General Health (p = .033)
    - Mental Health (p = .005)
  - Resilience (p = .031)
- LY participation decreased
  - Stress (45%)
  - Negative affect (76%)
  - Symptoms of depression for some participants (46%)

Key Findings

Aim 3- Open Ended Participant Responses

- LY participation improved participants' :
  - Mood
  - Stress level
  - Personal and professional relationships
  - Other health behaviors

Implications

- **Clinical Practice:**
  - Respiratory effect – increased peak expiratory flow rate
  - Future investigation of those with respiratory conditions is warranted
  - Increased positive affect, mental health and resilience
  - LY may be an alternative method for use as a mental health group therapy option or other group treatment
- **Education:**
  - Noted health improvements for this student sample
  - Potential beneficial addition to curriculum as self-care option for students
- **Policy:**
  - Provides preliminary evidence of effectiveness for complementary and alternative methods in promotion of health and wellness.

Strengths of the Study

- Experimental Design
- Scripted Sessions
- Research Assistant & Team Approach
- Mixed Method Approach
- Content Analysis by 5 Research Team Members

Study Limitations

- Specific sample
- Possible effect attributed to Certified Laughter Yoga Teacher
- Academic schedule of participants
- Short duration of study

Future Directions

- Replication of study in other populations
  - Varying military career fields
  - Patient populations
  - Veteran military
- Include third arm to strengthen study design
- Vary LY dose to determine dose effectiveness
- Explore time of day & gender as factors
- Investigate social support aspect

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La Gloria a Dios

QUESTIONS?

Namaste ☺





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Improving Healthcare Through Nursing